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LISTENING TO CUSTOMER INSIGHTS ON CREATING A CLIMATE STRATEGY FOR A CONSTRUCTION COMPANY

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TIIVISTELMÄ

Lappeenrannan teknillinen yliopisto
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Asiakkaiden näkemysten kuuntelu rakennusyrityksen ilmastostrategiaa laadittaessa

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Keywords: climate strategy, sustainability strategy, construction company

Ilmastonmuutos on yksi seitsemästä planeettarajasta, jonka ylittäminen johtaa maailmanlaajuiseen katastrofiin. Rakennusalan vaikutus ilmastonmuutokseen on merkittävä energian ja resurssien kulutuksen aiheuttamien kasvihuonekaasupäästöjen johdosta. Ilmastonmuutokseen vastaaminen on osa kestävää kehitystä, ja siten sidosryhmät painostavat yrityksiä ja organisaatioita ottamaan ilmastonmuutoksen osaksi strategista suunnittelua. Kestävyys- ja ilmastostrategioita voidaan tarkastella eri näkökulmista ja maturiteeteista. Yritysten kasvihuonekaasupäästöjen määrittämiseksi on myös luotu erilaisia standardeja ja raportointijärjestelmiä.

Tämän diplomityön tarkoitus oli muodostaa toimenpiteet rakennusyrityksen ilmastostrategiaan. Toimenpide-ehdotukset johdettiin suorittamalla ensin teoriakatsaus rakennusyritysten ilmastovaikutuksista ja selvittämällä case-yrityksen sidosryhmien, tässä tapauksessa kiinteistösijoittajien, kaupunkien ja kuntien, näkemyksiä puolistrukturoiduilla haastatteluilla. Haastattelujen teemat käsittelivät haastateltavien organisaatioiden ilmastotavoitteita, hiilijalanjälkilaskennan menetelmiä ja laajuutta, havaittuja haasteita ja rakennusyritysten roolia ilmastotavoitteisiin vastaamisessa. Rakennusyrityksen asiakkailla on monia ilmastonmuutostavoitteita, ja rakennusyritykset voidaan nähdä tukemassa niitä. Työn tuloksena löydettiin viisi painopistealuetta ilmastostrategiaan; tietoisuuden lisääminen rakennustuotteiden ja materiaalien ympäristöominaisuuksista, rakennustyömaiden toimintojen seuraaminen ja optimointi, energiatehokkuuden varmistaminen, elinkaariarvioinnin edistäminen sekä viestintä sidosryhmien kanssa.

ABSTRACT

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Listening to customer insights on creating a climate strategy for a construction company

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Examiner: Professor D.Sc. (Tech.) Risto Soukka, Associate Professor D.Sc. (Tech.) Mika Luoranen
Supervisor: Lic.Sc. (Tech) Mia Andelin

Keywords: climate strategy, sustainability strategy, construction company

Climate change is a one of the seven planetary boundaries of which exceeding will lead to global catastrophe. Construction sector has a significant contribution to climate change due to GHG emissions related to energy and resource consumption. Combating against climate change is a part of sustainable development and thus companies and organizations in various sectors are pressured by stakeholders and regulations to take climate change as a part of their strategic planning. Sustainability and climate strategies have diverse approaches, for example by perspective and maturity. In additions, several standards for defining GHG emissions as well as emissions disclosing projects has been created for companies.

The purpose of this thesis was to create actions for the climate strategy of a construction company. Suggested actions for the strategy were concluded by carrying out literature review of construction companies' climate impacts and investigating insights of stakeholder groups of the case company; real estate investors as well as cities and municipalities by semi-structured interviews. Themes of the interviews handled climate targets of the organizations, defining methods and scopes for carbon footprint accounting, observed challenges as well as role of construction companies on responding to the climate targets of the organizations. It was found that stakeholders have climate targets and construction companies can be seen supporting those targets. Five focus areas for the climate strategy were found as a result; increasing knowledge of environmental data of construction materials and products, monitoring and optimizing construction site activities, ensuring energy efficiency of buildings, promoting LCA practices as well as sustainability communication with stakeholders.

ALKUSANAT

Oli hienoa, että työharjoitteluni päätöksenä sain tehdä diplomityöni erittäin mielenkiintoisesta ja ajankohtaisesta aiheesta. Kevät työn parissa meni nopeasti. Opin paljon uutta rakennus- ja kiinteistöalan kestävyyshaasteista ja -mahdollisuuksista, ja kiinnostukseni alaa kohtaan kasvoi entisestään.

Haluan kiittää erityisesti Miaa työn ohjauksesta ja tuesta. Kiitokset myös työn tarkastajille Risto Soukalle ja Mika Luoraselle ideoista ja ohjauksesta. Olen kiitollinen jokaiselle, joka oli tukenani näiden viiden opiskeluvuoden aikana Lappeenrannan teknillisessä yliopistossa.

Helsingissä 24.5.2018

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LIST OF SYMBOLS

Abbreviations

BIM	Building Information Modelling
BREEAM	BRE Environmental Assessment Method
GCB	Green Construction Board
CDP	Carbon disclosure project
CO_2-eq	Carbon dioxide equivalent
CO_2	Carbon dioxide
CO	Carbon Monoxide
CNG	Compressed natural gas
CS	Corporate Sustainability
CSR	Corporate Social Responsibility
CEN	European Committee for Standardization
EED	Energy Efficiency Directive
ENCORD	European Network of Construction Companies for Research and Development
EU	European Union
EPD	Environmental Product Declaration
ETS	Emissions Trading Scheme
FFV	Flexible Fuel Vehicle
FIGBC	Green Building Council Finland
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
HVAC	Heating ventilation air condition
IEA	International Energy Agency
IEE	Intelligent Energy Europe
IIGCC	Institutional Investors Group on Climate Change
ISO	International Organization for Standardization
KTI	Kiinteistötieto [Property Information]
LC	Life Cycle

LCA	Life Cycle Assessment
LEED	Leadership in Energy and Environmental Design
LNG	Liquid Natural Gas
LPG	Liquid petroleum Gas
NGO	Non-governmental organization
NO	Nitrogen oxide
PD	Project Development
SYKE	Suomen Ympäristökeskus [Finnish Environmental Institute]
UK	United Kingdom
UN	United Nations
USGBC	US Green building Council
UNEPFI	United Nations Environment Finance Initiative
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

1 INTRODUCTION

1.1 Background

Climate change is a one of the greatest threats against humanity of our time. It is human, caused mega trend and it has serious and substantial effects on natural cycles, ecosystems and human beings all over the world. It has led and continuously leads to, for example, losses of species, water scarcity and destruction of natural habitat and biodiversity. Climate change due to the global warming is as a result of industrialization since greenhouse gases, especially carbon dioxide (CO_2), methane (CO) and nitrogen oxide (NO), have been released in the air from energy production and combustion processes. Greenhouse gases have accelerated the greenhouse effect in the atmosphere, which has led to the global warming (IPCC 2014). European Union has committed to the Paris Agreement which main purpose is to bring all the nations to common resolutions of mitigating and adapting to climate change and keep a global temperature rise under 2 °C and limit the increase 1.5 °C compared to pre-industrial time (European Commission 2018b). Mitigation means activities for reducing greenhouse gases (Schaltegger *et al.* 2013). European Union has set a target to decrease greenhouse gas emissions 20 % for the year 2020, 30 % for 2030 and 80-90 % until 2050 (European Commission 2018a).

Combating toward climate chance is a part of sustainable development. More stringent regulations and stakeholders demands have pressured companies to response to climate change. (WBCSD 2004, 3; Schaltegger *et al.* 2015, 4.) Companies should understand risks related to climate change and thus ensure stability of business operations in competitive business environment, as well as prepare themselves for future regulations (WBCSD 2004, 3). As a result, climate change has become as a part of companies' strategic planning. Companies' climate management strategies can be divided to adaptation or mitigation strategies or combination of both. (Schaltegger *et al*. 2015, 4.)

This study is made for construction and project development company Skanska Finland. Skanska Finland is a part of global Skanska Group. Skanska Group committed to the Paris Agreement in 2017 and Skanska Group determined as corporate's targets to "position itself

to be no.1 delivering profitable, resilient and zero/low carbon solutions to customers and set measurable carbon footprint target for the years 2030". In consequence of commitment to the Paris Agreement, by the Skanska Group and carbon target setting on group level, Skanska Finland is expected to set measurable carbon target on company's direct and indirect emissions in 2018. (Skanska AB 2017).

Construction sector has a significant role in actions to promote sustainable development as well as mitigate the climate change since the sector accounts for approximately 50 % of use of raw materials, 40 % of all the energy consumption and 40 % total human caused greenhouse gas emissions. Construction sector has also a significant influence on the society and global economy. It ensures the human quality of life, generates employment and incomes, and demands a great part of all the consumed energy and resources. (Santamouris 2016, 61.) Skanska has recognized this challenge and wants to contribute on mitigating the great climate impact of the construction sector.

1.2 Objectives

The aim of this thesis is to create the actions to the climate strategy of Skanska Finland by significance. The main drivers for this study are carbon targets of Skanska Group, hence interest to find how managing the construction company's climate impacts is associated with competitive advantage in construction sector in Finland. Research questions of the study are:

- Which operations cause the most significant part of climate impacts of the construction company?
- What are company's stakeholders' targets related to managing of climate impacts of a company and construction sector?
- Which activities are needed to be taken to reduce company's climate impacts and to meet Skanska AB's climate targets? Which activities support the climate targets of customer groups?
- What kind of climate strategy is reactive whereas which activities increase proactive approach to mitigating climate change?

1.3 Structure of the study

Potential actions for the strategy are found by studying construction company's climate impacts and business environment by following steps (also illustrated in figure 1):

1. Carrying out a literature review about companies' maturity levels for sustainability and climate strategy in the first theory chapter. Literature review includes also theory parts of defining climate impacts of construction company in the chapter three and reducing climate impacts from operations and actions that are the most significant and carbon intensities in the chapter four.
2. Empirical part is about researching insights of climate targets of construction company's customers; property investors and cities and municipalities, by interviews and
3. Finding potential actions to the strategy by carrying out a data analysis.

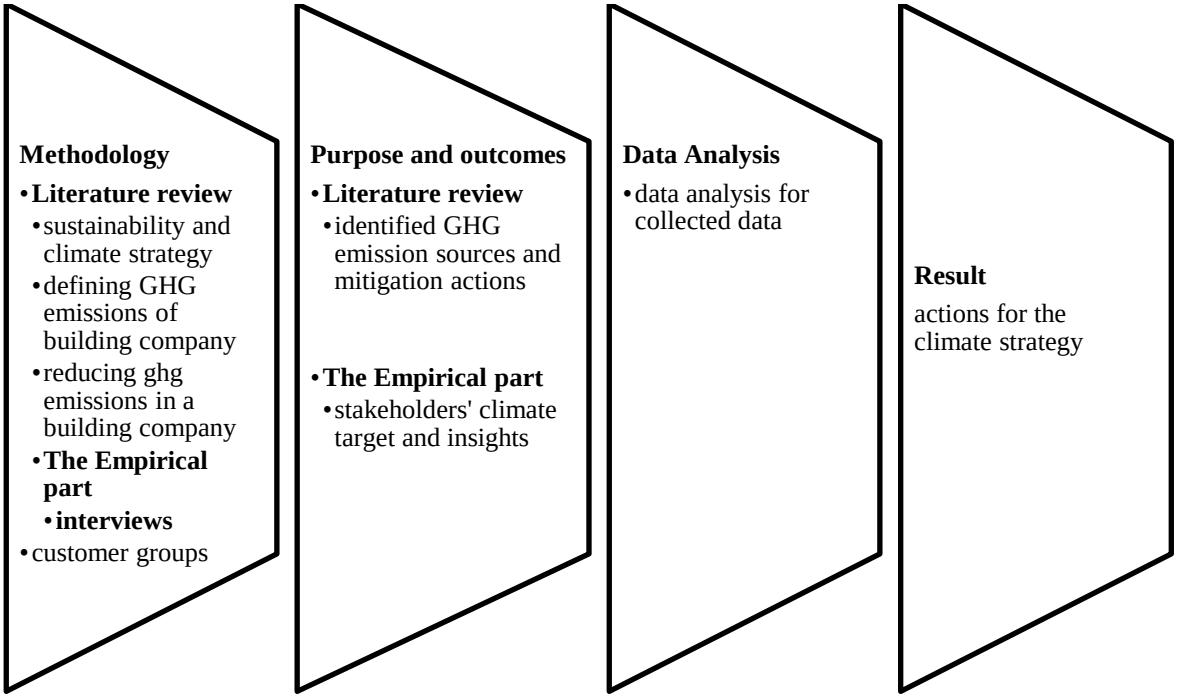

Figure 1. Structure of the study.

1.4 Introduction to Skanska Oy

Skanska Oy is a part of globally operating Skanska Group. It operates in fields of construction and civil construction as well as residential and commercial project development. In Finland, Skanska operates mainly in big cities and its head office is in Helsinki. Skanska Group's aim is to build for better society. (Skanska Oy 2018)

Skanska Oy has addressed corporate social responsibility issues in its strategy 2020; Company's aim is to be a leader in safety, ethics, and environmental responsibility and in risk management (Skanska Oy 2018). It has set long-term goals to improve energy efficiency and reduce caused climate impacts (Skanska Oy 2018b). One of Skanska values is "care for life" what means that it intends to promote sustainable solutions and point that the corporation is accountable to future generation (Skanska Group 2018). Skanska's operational system is certified according to ISO 14001 standard. In addition, Skanska Group has an own strategic sustainability framework tool, Skanska Color Palette. Color palette is globally used for a goal setting, communicating and measuring environmental performance of projects. Skanska's color palette includes five priority areas; energy, carbon, materials and water. The level of sustainability is defined by using three colors which are vanilla, green and deep green. Vanilla refers to compliance with law and regulations, green means that the level of project's sustainability is higher than regulations. Deep green is future proofing level, where project or product has near zero impacts on environment (Skanska Group 2018).

2 SUSTAINABILITY AND CLIMATE STRATEGY IN COMPANIES

This chapter discusses of companies' responsibility for sustainability and climate strategies. Company's stakeholders have an enormous influence on companies' environmental practices and strategic decisions (Vilchez *et al.* 2017). Company's stakeholders can be defined as "any group or individual who can affect or is affected by the achievement of an organization's objectives" (Freeman 2010, 46). Internal stakeholders are employees of the company. They are interested of success or failure of strategic decisions, and their aim is to avoid shutdowns and maintain normal operations. They are especially interested if company can save money or improve company's reputation by designing environmental practices (Vilchez *et al.* 2017). External stakeholders are such groups and individuals who are impacting outside the company's physical boundaries (Vilchez *et al*. 2017).

2.1 Sustainable Development

Sustainable development means development that notices current needs without compromising the ability of future generations to meet their own needs (WCED 1987, 16).). Rockström et al. (2009) brought other aspect to the concept by presenting the global sustainability as an approach that take planetary boundaries into account. Planetary boundaries refer to absolute limits of human activities and exceeding those boundaries leads to catastrophe due to significant environmental changes in the Earth. In this theory, seven measurable planetary boundaries have been addressed, which are climate change, ocean acidification, stratospheric ozone, biogeochemical nitrogen cycle, phosphorus cycle, global freshwater use, land system change and loss of biological diversity. (Rockström *et al.* 2009.)

Sustainable development can be seen consisting of three pillars of environmental, economic and to social sustainability (Griggs et al. 2013). Three pillars of sustainability, environmental, economic and social or so called triple bottom line has been also used in the context which refers to companies' sustainable development. Due to international agreements and policy decisions, sustainability issues have become more and more important also in the companies. Companies must take the all three aspects of sustainability into account while trying to meet

the needs inside the company and external stakeholders. (Engert & Baumgartnerg 2016, 822.)

2.2 Companies' responsibility for sustainability

In the literature, various terms have been used for defining corporate sustainability and corporate responsibility goals and activities. One of the most traditional terms is corporate social responsibility (CSR) which refers to companies taking responsibility for impacts that are caused on society by the company. It includes following the law and integrating social environmental, ethical, consumer and human rights issues into CSR. (European Commission 2018c.) The term of corporate sustainability (CS) can be seem as including strategies and practices that aims to meet the needs of stakeholders while reaching to protect, support and enhance the human and natural resources also in the future. Thus, companies are responsible for all three sustainability dimensions. (Ketola 2010; Kasurinen 2017, 44.)

Companies' sustainability practices and maturity have been also assessed in literature. For example, Masalskyte *et al*. (2017) discusses on maturity levels of sustainability practices in companies in the real estate sector, and Kasurinen (2017, 78) discusses on the maturity of corporate responsibility for sustainability which has been used for companies in the bioenergy sector. Figure 2 illustrates three maturity levels of corporate sustainability (kasurinen 2017, 78). There are three maturity levels in the model, which are based on the objective and the type of sustainability measures, the nature of responsibility and measures as well as the level of creative in companies.

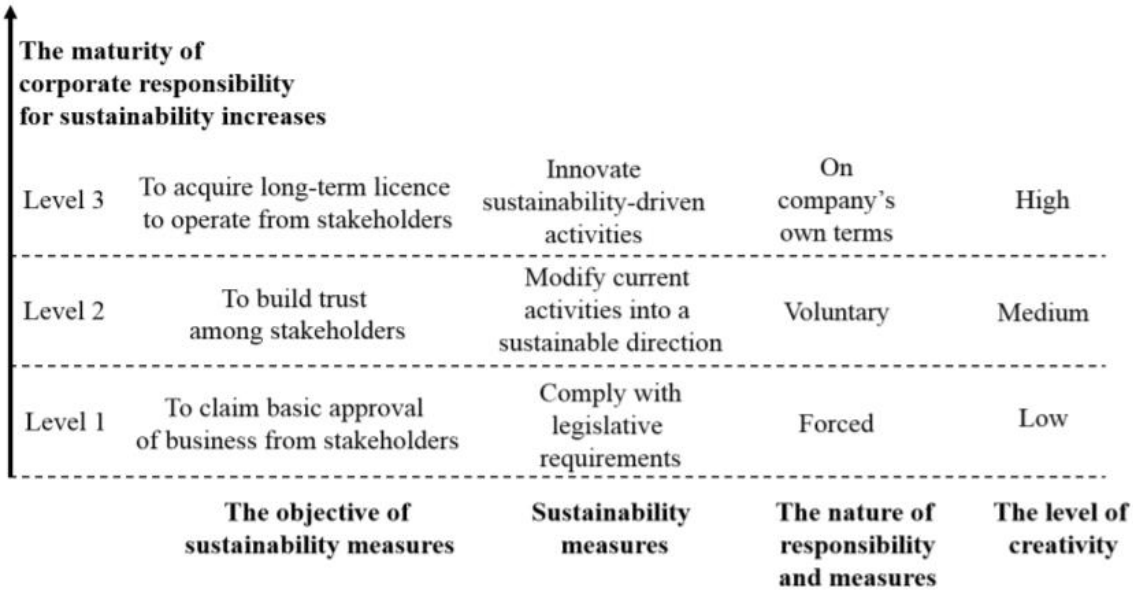

Figure 2. Three maturity levels of corporate responsibility for sustainability (Kasurinen 2017.)

At the maturity level 1, the level of creativity is low, company is doing sustainability practises that are mandatory by legislation. Compliance with legislations is seemed as precondition for an acceptable business. Thus, at the level 1 the objective of sustainability measures is to claim basic approval of business from stakeholder. At the following levels, companies have more advanced approach to practising sustainability measures. At the level 2, the objective of sustainability measures is to build trust among stakeholders. Companies at this level are voluntarily modifying current activities into more sustainable direction. For example, voluntary certifications can enable companies to practising higher sustainable direction as well as meet the expectations from stakeholders. At the highest level of maturity, companies' main object is to reach a long-term licence to operate from stakeholders by innovating sustainability driven activities. (Kasurinen 2012, 78.)

2.3 Climate strategies

Concerns about climate change are increasing and therefore various groups of companies' stakeholders, non-governmental organizations (NGOs), investors and other stakeholders are interested in companies' climate-related actions and how companies are acting compared to competitors (WBCSD 2004, 12). For example, Blanco *et al*. (2017) discusses firm's motivations for participating carbon disclosure project (CDP), and claims sources of motivation

such as “public communication, stakeholders’ interests (customer, employees, investors), transparency, the need to measure if you want to change, cost reduction, legal requirement and need to understand environmental impacts”. Investor’s demand has been seen as a main driver for carbon disclosing. (Blanco *et al.* 2017, 638.)

Climate change related policy and market dynamics have led to loaners and investors consider carbon intensity assets as financial risks (UNEPFI 2012, 11). Risks for investors related to climate change can be classified to three types; physical risks that asset can face, financial risks which can occur due to climate mitigation policies or technological or economic trends. Third type of risk is potential legal liabilities. (UNEPFI 2012, 15.) Sullivan & Gouldson (2012, 60-61) claims that reasons, why investors should be concerned about greenhouse gas emissions from their activities, are the cost (taxes or trading scheme) of emissions, possible cost-savings through decreasing energy consumption, energy efficient products and services as well as avoiding negative reputation and negative consequences of late approach to climate change. Physical risks are weather-related impacts of climate change which companies can face, such as floods, storms and rising sea level. Companies’ climate management and activities to respond toward climate change related risks and opportunities may have financial implications, and thus investors have reacted to those risks and opportunities by concerning them in investment decisions. (Sullivan & Gouldson 2012, 60-61; Mercer 2013.) Investors have an opportunity to shift investment targets toward low carbon investments (Sitra 2016, 9).

United Nations (UN) has set a goal to ensure sustainable cities and communities. This goal includes for example, aims to reduce environmental impacts of cities and bring policies towards resource efficiency and mitigation and adaptation to climate change to agendas of cities. (United Nations 2015.) Cities has developed their own climate change mitigation and adaptation strategies. Cities and citizens can be seen to have shared responsibility of mitigation and adaptation. Implementation of strategies requires more or less involvement of third parties such as businesses, utility owners and industry sectors. (Heidrich *et al.* 2014, 42.)

One approach assessing and measuring the matter is carbon accounting. Carbon accounting delivers data for external and internal stakeholders along a supply chain. Carbon intensity of

products may be sometimes the main interest of customers. Also, customers ask for GHG emissions for reporting and decreasing their own carbon footprint of a supply chain. (Blanco *et al.* 2017, 639.) In addition, product's GHG inventory may help customers to reduce emissions, for example by reducing electricity use, in the usage stage. This is also associated to cost reductions. (WBCSD 2011). It has been presented that communication with internal as well as external stakeholders is an important part of sustainability strategies. Communication with internal stakeholders enable strategy implementation and the change in processes toward more sustainable organization. (Newig *et al.* 2013.) Newig *et al.* (2013) suggests that recognition and dialogue with stakeholders are part of CSR communication. On the other hand, companies communicating the environmental benefits might increase customers' interest toward products (Gauthier 2017, 31).

2.3.1 Approaches to the strategies

Climate strategy can be defined as company's choice between various strategic options in response to climate change. It has been also defined as "a complex set of both market and non-market activities designed mainly to reach market gains but also to maintain political influence". (Kolk & Pinkse 2005; Okereke &Russel 2010.) Damert *et al*. (2017) defines corporate carbon strategy as a complex set of activities to reduce the impact of a firm's business activities on climate change and to gain competitive advantage over time. Corporate carbon strategy can be defined by identifying the carbon management activities that a company prioritizes and the resources it allocates to these prioritized activities (Lee 2012). Recognized factors which have influence on corporate's climate strategies are regulatory framework, market positioning, technology availability and societal demands (Sa de Abreau *et al.* 2017).

It has been studied that companies have various options of perspectives from which they can create climate management strategies. *Production* perspective refers to company's positions in the value chain, and climate activities can be determined by the position. *Product design* perspective focuses on product changes and product development. *Supply chain* perspective is useful for including indirect emissions that are caused upstream and downstream in a value chain. Company can also focus on *choosing resources*, for example by seeking less carbon

intensive fuels and materials. Possible perspectives are also *company locations, distributional channels and business models*. (Schaltegger *et al.* 2015, 4.)

2.3.2 Defining Climate impacts of a company

Emerging interest for the accounting carbon emissions is as a result of stakeholders' awareness of climate change and international agreements, such as the Kyoto Protocol and the Paris Agreement. Hence, there have been generated various reporting and calculation methodologies as well as guidelines for companies' GHG emissions. (Harangozo & Szigeti 2017.)

Harangozo & Stigeti (2017) defines corporate level carbon footprint as GHG emissions related to the activities and products of a company. The major international standards for corporates' carbon management accounting for corporate level or product level are Greenhouse gas protocol which has been developed by World Resources Institute and the World Business Council for Sustainable Development, PAS 2050 of British Standard institute as well as ISO standard 14067 for carbon footprinting of products and 14064 standard for GHG reporting on organizational level. (Schaltegger & Csutora 2012).

Corporate level carbon footprint account is useful when company has aim to decrease carbon emissions. The account points out where the biggest energy, material and other resources are used in the value chain. (Navarro *et al*. 2017, 724.) In literature, there has been found that application of corporate level carbon footprint can be beneficial for companies in many ways, not only achieving climate targets. Defining carbon footprint can help companies to recognize possible targets for cost savings. It also helps companies to integrate environmental perspectives to different functions and activities. (Harangozo &Szigeti 2017)

Carbon Handprint

Standards and guidelines of GHG reporting focus on corporate or product level carbon emissions; negative climate effects caused by corporate's activities. Products and solutions that companies provide may have positive effects. Environmental handprint refers to positive

changes, such as lower emissions or energy or water consumption or higher material efficiency, that company can causes to individuals or to other companies (Norris 2015). Handprint can be associated to product or company level. The handprint of the company includes footprint of the company, but also the positive effects the company provide for individuals or other organizations. Such positive effects are for example, caused by doing changes in the supply chain or indirectly in company's products or services. Handprint of a product means prevented or avoided negative impacts that would have occurred. On the other hand, handprint of product can be also created by making positive benefits that would not have done without the product. (Norris 2015a; Norris 2015b; VTT 2016, 5.) There doesn't exist accepted standards for handprinting, because the concept of handprint is new and still being developed (VTT 2016; Pajula *et al*. 2017).

Carbon neutrality

Carbon neutrality is a widely used term to describe companies' strategic sustainability targets, goals or visions. In companies, carbon neutrality is often defined as a condition in which the subject has caused zero net GHG emissions to the atmosphere during one year (Alhola *et al*. 2015, 5). ISO 14021 (2016, 27) defines carbon neutral as a product which has carbon footprint of zero or carbon footprint of product has been offset. In some cases, carbon neutrality represents a low carbon course of action (Seppälä 2014, 30). In some companies, carbon neutrality is associated to independence of fossil fuels. It can be concluded that carbon neutrality is not an established concept, and organizations have different definitions for carbon neutrality. Therefore, carbon neutrality has been used in different context for defining goal of a certain organization. Cities has used the term for representing significant reductions of GHG emissions. (Seppälä 2014, 25-26.) In Finland, there are not many companies where carbon neutrality would be addressed as a goal for all the business operations. Currently, it is more general that only part of business operations is defined as carbon neutral. It is assumed corporates have the most concrete way to use carbon neutrality for describing their strategic aims, and reporting GHG emissions is performed by year to year. (Seppälä 2014, 28, 29.)

Methods for reporting GHG emissions

Major institutional investors require companies to disclose data of GHG emissions by using platform of voluntary projects such as Carbon Disclosure Project (CDP), which is the most popular disclosing channel. Disclosing information through questionnaire of CDP enables gathering detailed and transparent data of companies' impacts on climate change. (Okereke 2007, 482.) CDP requires companies to measure and disclose greenhouse gas emissions that are produced inside the boundaries of a company as well as indirect emissions from the supply chain. CDP transforms data from companies to analysis on environmental impacts, risks and opportunities. CDP follows disclosing method of GHG protocol standard. In addition, companies are expected to identify their climate change related-risks, strategies and actions (CDP 2018; Blanco *et al.* 2017, 636.) Disclosing emissions can encourage firms to reduce their emissions. Also, firms have founded that following CDP they can reach benefits such as preparing to regulations, rising ability to quantify stakeholders interest and improving communication with them as well as increasing understanding of impacts opportunities and risks (Blanco *et al*. 2017, 643). It is important to notice, that scope 3 disclosures are discretionary, firms can determine which categories of scope 3 they include to the report; For example, it has been assumed that companies in USA include approximately 20 % of their all indirect emissions from the value chain to CDP (Blanco *et al*. 2016).

Greenhouse gas emissions are also considered in GRI G4 Sustainability Reporting Guidelines in the emission Aspect. Reporting follows standards of GHG Protocol. Scope 1 emissions are addressed by indicator G4-EN15, Scope 2 G4-EN16 and Scope 3 G4-EN17. Also, greenhouse gas emission intensity (G4-EN18) and reduction of greenhouse gas emissions (G4-EN19) are included in the guidelines. (GRI 2015, 57.)

3 DEFINING CLIMATE IMPACTS OF A CONSTRUCTION COMPANY

This chapter discusses of construction processes and standards for defining climate impacts in the construction sector. There are various models of construction contracts which determines the area of responsibility of each actor in a construction project. In this thesis, the case where construction company (contractor) is responsible for both planning and construction activities is handled.

This section discusses of stakeholders of a construction companies as well as construction processes in an aspect of sustainability.

3.1 Stakeholders of a construction company

Svenfelt *et al*. (2011) uses five stakeholder groups of building construction sector. In this approach, stakeholder groups are

1. authorities,
2. residents,
3. users of commercial properties,
4. builders/contractors
5. property owners/managers (Svenfelt *et al*. 2011, 788).

Zhao *et al.* (2012) has two approaches for identifying the key stakeholders of construction enterprises, that are project level stakeholders and corporate level stakeholders. Two levels are shown in the figure 3. When it comes to the corporate level stakeholder groups, according to Zhao *et al.* (2012) those are employees, shareholders, creditors, local communities, government and Non-governmental organizations (NGO's).

In the project level, customers of the company are investors of future property users, and thus company should meet needs of both of them. Investors are involved since initiating of the project up to operation and maintenance stage. Investors are owners of a property who

operate in the real estate sector, organizations such as public institutions or enterprises or partners who has made the project contract with construction contractor. Other major stakeholders of construction process are project managers, designers, shareholders, local authorities, sub-contractors and suppliers. (Jin *et al.* 2017, 316; Zhao *et al*. 2012.) Stakeholder groups can be divided to internal and external. Clients and project owners are internal stakeholders; they have managerial role and responsibility over the project. Local communities, regulators, potential users of property are included to external stakeholder and they may have impacts on project by regulations or direct actions. (Jin *et al.* 2012, 316.). Suppliers has been identified as an integral part of construction industry, and they are mainly interest in viability a company while they can be supposed to meet various requirements by a construction company. (Zhao *et al.* 2012, 283.)

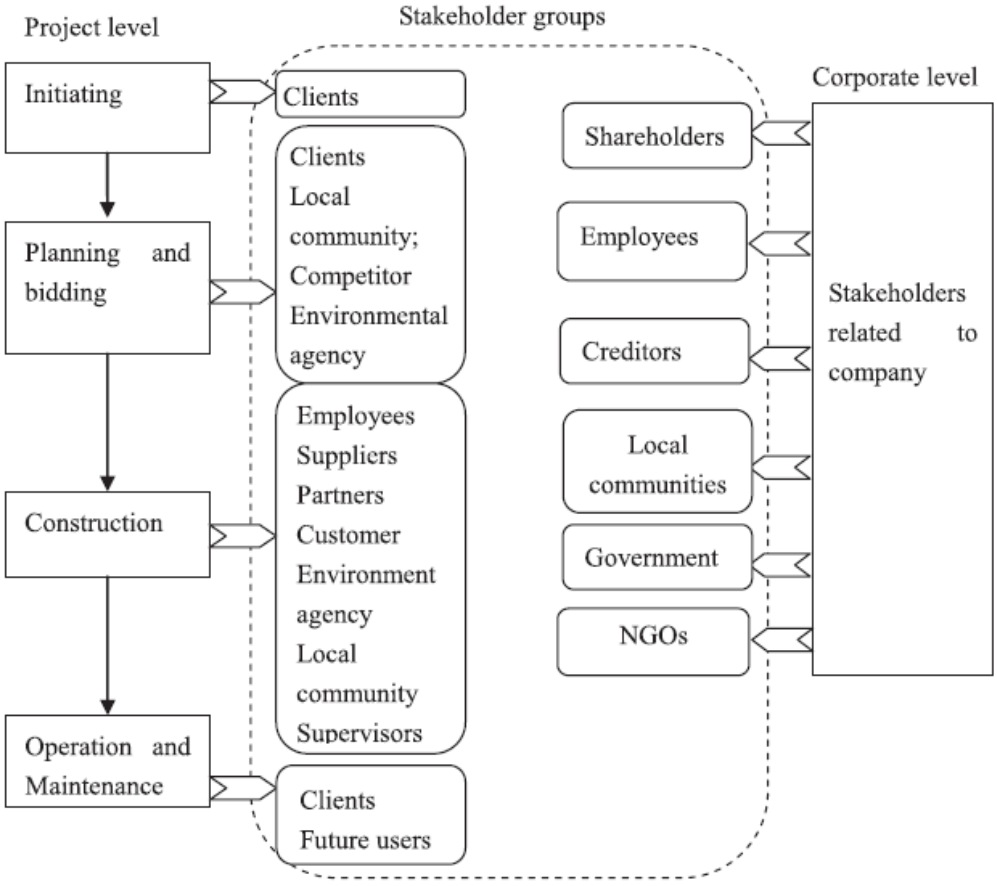

Figure 3. Stakeholders of Construction Company (Zhao *et al.* 2012).

3.2 Sustainable construction processes

Construction includes processes from design stages, engineering and procurement activities to building's life cycle operations such as operation, maintenance, re-construction, demolition and recycling. Sustainable construction processes provide sustainable products meeting the needs of all the participants involved. (Persson *et al*. 2008; Häkkinen *et al*. 2015.) In general, main operations of a construction company can be divided to four simplified processes; initiating, planning, construction operations and operational phase of building (RT 2013 10-11105). In addition, planning phase can be divided to project planning phase and building planning phase. Bidding phase can be also considered separately (Zhao *et al*. 2012). Initiating and planning phases are part of project development phase (Fröch 2015, 4).

Design phase has a considerable influence on project's sustainability since life cycle's environmental impacts of building are mainly determined during early design phase by decision which are made. (Basbagill *et al.* 2013, 81). For example, ability to effect on made decisions in relation to awareness the emission impact caused by a project is illustrated in figure 4.

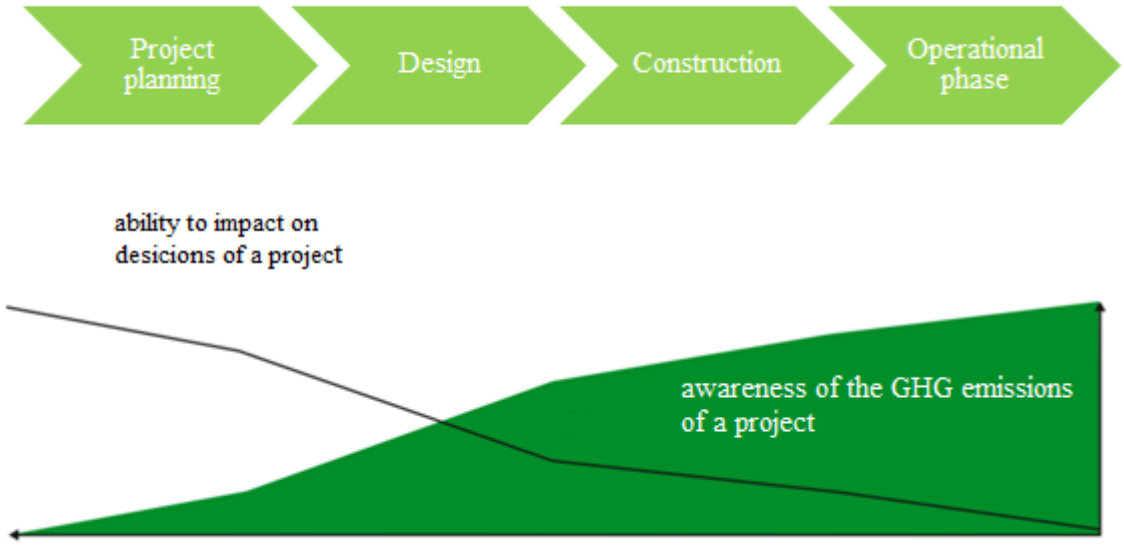

Figure 4 Ability to impact on project's decision related to awareness of the GHG emissions of a project. (Modified from FIGBC 2013)

Environmental issues should be taken in to design decisions as earlier as possible, already during the land acquisition phase. Changing design decisions in the later phases has been studied to have cost increasing impact. (Ding 2007, 452.) In construction companies, if environmental assessment tools are intended to be used, it is important to take the tools in use during the earlier design phase before detailed design decisions or commitment have been made. (Ding 2007, 451-452.) USGBC (US Green building Council) addresses five elements of sustainable or green building design, which are 1. Sustainable site design, 2. water conservation and quality, 3. Energy and environment, 4. Indoor environmental quality, 5. Conservation of materials and resources. Designer can affect on following aspects:

- building shape and orientation and thus maximize passive solar energy
- efficient use of space
- energy intensiveness and energy consumption by energy efficient lightning, appliances and HVAC system
- building materials selection and dimensioning
- Construction practices (Basbagill *et al*. 2013, 82; Ragheb *et al*. 2016, 779).

Sustainable procurement can be generally defined as "a process whereby organizations meet their needs for goods, services, works etc. in a way that achieves value for money on a whole life cycle basis in the terms of generating benefits not only to the organizations but also to society and the economy, while minimizing damage to environment" (Sustainable procurement task force 2006, 10). In a construction process, procurement covers activities providing products, services and works needed to complete the goals of a project (Ruparathna & Hewage 2015). Stakeholders and targets of lower cost pressure companies to manage their supply chains in the way they meet environmental expectations (Ofori 2000). Organizations can increase their environmental performance but also impact on their suppliers' environmental performance by including environmental requirements to purchase policies and decisions (Varnäs *et al*. 2007, 1214; Ofori 2000). Ofori (2000) discusses of purchasing strategies in which environmental aspects can be taken into account. Such strategies are, for example; informing suppliers, implementing product life cycle stewardship programmes, training programmes, collaboration, auditing suppliers, purchasing products with desired environmental attributes such as recycled materials, non-harmful ingredients etc.

Construction phase includes transportation of building materials and construction methods. Construction activities generally are modeled, scheduled and monitored and controlled for managing costs, time and quality of a project, whereas environmental monitoring methods are claimed to be limited (Russell-Smith & Lepech 2015). However, construction causes harmful impacts on environment, for example, trough usage of resources, waste generation, and energy consumption. (Santamouris. 2016).

3.3 Defining GHG emissions of the construction sector

In this section, standards for defining GHG emissions in a company level are discussed and for assessing environmental impacts of buildings' life cycle.

3.3.1 GHG Protocol's standard for Corporate GHG emissions

Greenhouse gas protocol's Corporate accounting and reporting standard sets requirements and guidance for determining corporate level GHG emissions. Its aim is to help companies to create a GHG inventory with reliable account of emissions, to create strategy to manage and cut GHG emissions. Objectives of the standard are also to provide information for voluntary and mandatory GHG programs and increase consistency and transparency between companies and different GHG programs. (WBCSD 2004. 3.) Standard has been created by World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (WBCSD 2004, 2). Standard takes seven greenhouse gases; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) into account. Standard can be used in companies and in other organizations such as NGOs, governments and accounting associations. (WBCSD 2004.)

GHG Protocol separates sources of GHG emissions to three scopes based on operational boundaries. Scope 1 is defined as a direct GHG emissions from sources which are owned or controlled by the company. For example, scope 1 emission sources are boilers, vehicles and furnaces in combustion or production processes. Direct emissions, which are produced by biomass combustion process, should not be incorporated to scope 1.

Scope 2 emissions are called as electricity indirect emissions. Scope 2 emissions are from generation of purchased electricity that means electricity which is produced outside the boundaries of the company. Companies should at least separately report on scope 1 and 2. Scope 3 covers all the other indirect emissions from upstream or downstream activities that are produced from sources not owned or controlled by a company, but emissions are formed as a result of company's activities. Such activities are transportation, activities needed to produce purchased material etc. Scope 3 is optional reporting category. (WBCSD 2004, 25.)

In many business sectors, scope 1 and 2 emissions are often only a small part of total emissions; on average 26 % in the industry sector (Matthews *et al*. 2008, 5839). According to Huang *et al.* (2009, 509) the share of the scope 3 emissions is approximately 75 %. It can be concluded that if scopes 1 and 2 are only included to carbon reporting, only the smallest part of life cycle GHG emissions is considered. (Matthews *et al.* 2008, 5842). Scope 3 emissions are often voluntary included to company's GHG reporting by following GRI G4 sustainability reporting guidelines or carbon accounting organizations such as Carbon Disclosure Project (CDP) (Blanco *et al* 2016, 1189). Scope 3 reporting is challenging to companies, and the major challenges are related to information about sustainability impacts of products and processes (Boström *et al.* 2015). Controlling scope 3 needs changes in the product design for reducing consumer impacts (use phase) and in procurement activities, for example auditing suppliers and moving to green supply chain management. (Schaltegger *et al* 2015, 12.) Blanco *et al.* (2016, 1189) noted that understanding of upstream emissions is important to companies, otherwise they will miss out the significant climate mitigation strategy in an aspect of cost-effectiveness.

ISO 14064-1 (2006, 18) presents some activities that cause other indirect emissions on scope 3:

- GHG emissions from the production of purchased raw materials.
- business travels of employees
- transportation of people, products, materials or produced waste
- outsourced activities such contract operations
- GHG emissions from waste management

- GHG emissions from the use phase and end-of-life phases of the products or services, which company produces;
- GHG emissions from the production and distribution of energy products that are consumed by the organization (not electricity, steam or heat)

Direct and indirect emissions caused during a value chain were illustrated in the figure 5.

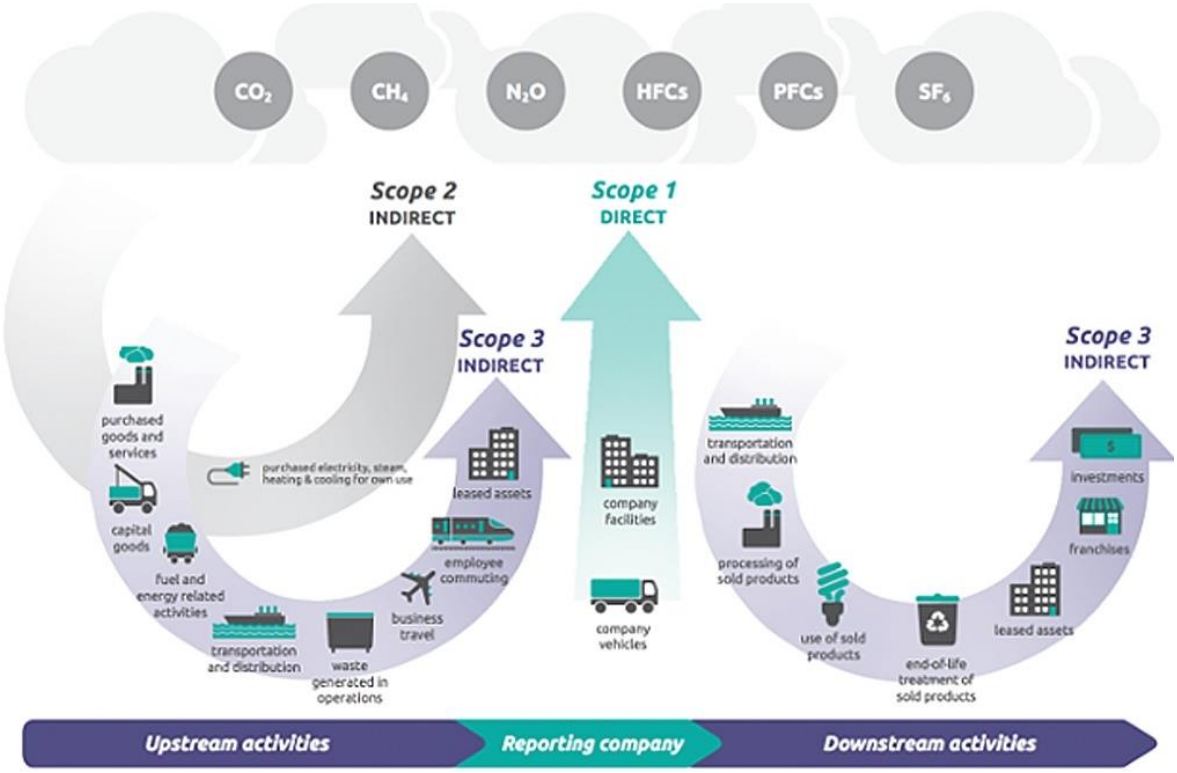

Figure 5 Illustration of direct and indirect emissions caused during value chain based on GHG Protocol (WBCSD 2004)

3.3.2 ENCORD for construction companies' GHG emissions

European Network of Construction Companies for Research and Development (ENCORD) has published a guide for construction companies for reporting GHG emissions by following the standard of GHG Protocol (ENCORD 2012). The guide has been appointed for large construction companies which operates as a main contractor or large subcontractor (ENCORD 2012, 8).

According to ENCORD (2012), the value chain of a construction company can be divided to three primary areas of operation for GHG inventory; materials manufacture, construction

and operations as follows (table 1). GHG emissions which company has control or influence should be reported under those three key operation areas. Supporting services and activities of the company should be also included into GHG inventory in a relevant way.

Table 1. An example of the value chain of a construction project

1. Material Manufacture	• production of raw materials • processing to useable form • transport of product/materials
2. Construction (and relative activities)	• design • site office • plant • transport • demolition/ remodel or refurb
3. Operation	• preoccupation and use • occupancy
+ Support services and activities[1]	• business travel, operation of offices and other premises etc.

Corporates should assess also the significance of the emissions from the source while assessing emission sources. There has been recognized six different criteria for determining significance; magnitude of GHG emissions, financial spend, stakeholder demand relevance to the one's business, such activities which corporates has the most impact over, potential for emission reductions and contribution to risk exposure. (ENCORD 2012, 18.)

ENCORD guidance follows GHG protocol's standard by addressing three scopes of emissions. ENCORD has identified 12 most significant emission sources which are presented in table 2.

Table 2. The most significant construction company's emissions divided to scope 1, 2 and 3. (ENCORD 2012, 20)

Scope 1	1 Fuel, project 2 Fuel, premises 3 Process and fugitive (7. Vehicle fuel)
Scope 2	4 Electricity, project 5 Electricity, premises 6 Imported heat (7.Vehicle fuel)
Scope 3	(7. Vehicle fuel) 8 Public transport 9 Subcontractors 10 Waste 11 Materials 12 Product

Companies are supposed to measure sources from 1 to 7, in the other words scope 1 and 2, (Table 2) as a minimum level. Those emissions are fuel (project), fuel (premises), process and fugitive, electricity used in project and premises, imported heat and vehicle fuel. Indirect emission sources which are addressed by ENCORD as the most relevant and significant are vehicle fuel, public transport, subcontractors, waste, materials and products. (ENCORD 2012, 20.) Companies should report separately GHG emission inventory for different construction activities, or sectors and projects. The inventory result should be compared within the certain sector and project type. Sectors are residential buildings, construction of non-residential as well as infrastructure, whereas project types are commercial buildings, public buildings, residential buildings, roads, rails etc. (ENCORD 2012, 11.)

Direct emissions (Scope 1) includes emission sources 1-3. Fuel for projects covers all fuel which is used in construction site and asset which are managed by company. Fuel for premises includes all fuel which is used at premises and is purchased by the company. Such fuels are, for example diesel, petrol, fuel oil, heating oil, natural gas, gas oil, LPG (liquefied petroleum gas) and compressed natural gas (CNG). Direct emissions are also GHG emissions

from physical and chemical processes which are owned or under the control of a company as well as fugitive emissions from refrigerant leaks from equipment. Also, fuel for business travel by vehicles which are owned or controlled by company should be included into this section (ENCORD 2012, 23).

According to ENCORD (2014, 24) scope 2 emission sources are electricity used in projects and premises as well as imported heat used in projects or premises. Electric cars and other transports owned by company or privately owned paid by company are also included into scope 2 (ENCORD 2012, 24).

The scope 3 includes emissions from commuting travels paid by company which company has less control over (source 7). Also, all public transport (source 8) related to company's activities used by employees and paid by a company. Hence, transportation distances and conversions factors for travel kilometers should be evaluated. Source 9 about subcontractors covers emissions which are caused by subcontractors in the project level. Emissions from subcontractors' operations should be considered separately from fuel (project) and electricity (project) which are identified to be caused by a company. Emissions caused by waste disposal, treatment and transportation is considered as indirect emissions from a source 10. Source 11 is materials and it includes all materials and product purchased to a construction project. ENCORD focuses construction materials that are widely used and high energy and carbon intensive. (ENCORD 2012, 25.)

Source 12 refers to downstream emissions of a product, on the other word to a operational phase of a product during expected lifetime, or in this case, building's life time (or infrastructure asset). According to the ENCORD, emissions from this source are not specially calculated. It is recognized that operational phase has a great emission reduction potential though. Performance of the product, such as the energy performance certificate, should be reported. (ENCORD 2012, 26.) GHG emissions of the operational phase of building is defined as the operational carbon footprint. It illustrates user's contribution to GHG emissions. It includes GHG emissions of energy consumption, but it can cover also emissions from waste management, refrigerants, vehicle fuels and emissions from maintenance. (FIGBC 2016.)

3.3.3 EN 15978 Assessment of environmental performance of buildings

EN 15978 standard of Sustainability construction work –assessment of environmental performance of building has been made by Technical Committee CEN/TC 350 "sustainability of construction works". Environmental performance refers to "performance related to environmental impacts and environmental aspects". The meaning of the CEN TC 350 standards is to provide calculation methods and rules for building's environmental assessment, based on Life Cycle Assessment. It can be used for existing and new buildings. Life cycle approach includes all the used building related materials, processes and services during the life cycle. In the standard, life cycle of building is divided to four stages as shown in figure 6; product stage, construction process stage, use stage and end of life stage, which are shown in figure 6. Environmental benefits or load caused by reuse, recycling and energy recovery during life cycle of building can be can be considered in module D.

Type of impacts	Initial embodied impacts					Recurrent embodied impacts					Operational impacts		EoL embodied impacts				
Module	Raw material supply	Transport	Manufacturing	Transport	Construction - installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction	Transport to EoL	Waste processing	Disposal	Reuse, recovery or recycling potential
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Life cycle stage	Product stage			Construction process stage		Use stage							End of Life stage				Benefits and loads beyond system boundary

Figure 6. Life cycle environmental impacts of a building (Framussen et al. 2018).

Product stage covers cradle to gate processes of building products and services. Defining of product stage's environmental impacts are discussed in the Standard EN 15804 for Environmental product declaration. (EN 15978 2011, 20.) Stage of construction processes includes transportation of products from factory to the construction site as well as storage and distri-

bution after factory and transportation of construction machines as well as losses which occur due to transportation. (EN 15978 2011, 20.) According to the Standard, module 5 of construction process should include processes as follows;

- ground works and land scaping
- storage of products
- material, products, waste and equipment transports
- production and material preparations on the site
- temporary works and off-site temporary works
- heating, cooling etc during the construction
- product installations
- water use
- management of the caused waste. (EN 15978 2011, 22.)

The use phase is defined as a period from completion of a construction process to the phase when building is deconstructed or demolished. This stage includes products, services for protecting, moderating and controlling the asset, such as heating, cooling, lighting and water supply, and operations of escalators and elevators. This stage includes also maintenance operation such as cleaning. Modular of the use stage are also repair, refurbishment and replacement.

Module B6 consider the operational energy use and module 7 operational water use (EN 15987 2011, 24, 27). The operational energy should include energy that is used in heating, domestic hot water supply, air conditioning, ventilation, lighting and auxiliary energy used for pumps, control and building automation. Energy use in electrical appliances should be calculated separately, if considered. This is handled properly in the Standard EN 15603. Module B' boundary should cover water use water treatment during normal operation of building. This should include processes for drinking water, water-sanitation, domestic hot water, irrigation of for example, green roofs and water for heating, cooling, ventilation or humidification as well as other specific water use systems. (EN 15978 2011, 27.)

End of life stage begins when building is not in removed from the use and building can be seemed to be reached end of life when all components and material have been removed, and

the site is made ready for future-use. Hence, this stage includes deconstruction, transportations to disposal and processing, reusing, recovery and recycling of waste as well as disposal of materials. (EN 15978 2011, 27-28.)

4 REDUCING CLIMATE IMPACTS IN THE CONSTRUCTION SECTOR

In this section, regulative and stakeholder aspects for decreasing climate impacts of building and construction processes are discussed. In addition, strategies to decrease GHG emissions related to activities of a construction company, based on scope 1, 2 and 3 emissions sources, are discussed. The operational phase of buildings is not usually controlled or owned by a construction company. However, solutions that determine the energy consumption in the operational phase are mainly defined in planning and design phase.

4.1 Regulative aspects

In Finland, Land use and Building Act (132/1999) determines land use and building activities. The purpose of the Act is to ensure preconditions for favorable living environments while promoting sustainable development. It is stated by the Act that area planning should promote environmental aspects, for example, by ensuring the protection of biodiversity and other nature values, preventing harmful effects on environment and promoting environmental protecting and ensuring economical use of natural resources. In the Act, it is also stated that objectives of building guidance should promote, for example, sustainable and economical lifecycle of properties as well as "the planned and continuous care and maintenance of the build environment". (L. 132/ 1999 § 5-12.) A one, who is responsible for a construction project must make charge of the providential use of energy and natural resources (L. 132/1999 § 117).

In Finland, regulation over climate impact of buildings focuses on energy consumption of buildings. National building regulation and energy targets are based on directives of European Union. Main directives are Energy Efficiency directive (EED) and Energy Performance of Buildings Directive. EED includes energy efficiency target of 30 % improvements by the year 2030. It includes policies such as the public sector in member countries should purchase building, services and products which are energy efficient. Also, large companies are required to perform energy audits of their energy consumption and energy consumers overall should have easy access to their energy consumption data (European Commission 2017).

Energy Performance of Buildings Directive determines that energy performance certificate must be shown at construction permit phase. It must be included to advertisements for the sale or rental buildings and all the new building must reach nearly zero energy level by the end of 2020 and public building until the end of 2018 (D. 2010/31/EU).

Regulation concerning closely the construction sector is also the Waste Act. It is stated that following types of waste must be collected separately; concrete, brick, ceramics and mineral slabs, gypsum, unsaturated wood, metals, glass, plastics, paper and carton, as well as soil and rock material. It has been determined that 70 % of construction waste must be conducted for recycling or reuse (excluding hazardous waste and soils and rock materials) until the year 2020. (A. 19.4.2012/179 § 16)

The importance of resource efficiency in the building sector was addressed in the project of European Commission of resource efficiency opportunities in the building sector. European Commission's proposal of resource efficiency indicator includes life cycle carbon footprint and emissions, resource efficient use of materials, water consumption, indoor air quality, adaption to the climate change and life cycle costs. (FIGBC 2016.) In Finland, GHG emissions of the new buildings' life cycle has been intended to regulate by law until the middle of 2020. Ministry of Affairs and Employment of Finland stated in its Climate Strategy 2016 that decreasing of carbon emissions of building materials will be included to building regulation. Thus, Ministry of the Environment published a roadmap for reforming regulation of buildings' life cycle carbon emissions in June 2017. The roadmap presents that carbon emissions of building materials will be included to the Finnish building code as limiting values by 2025. Before that, there will be two preparation stages. The first stage (2017-) is about testing and developing GHG-measuring tools, and the second (2019-) is for developing of a controlling system. (Bionova 2017.) Finnish roadmap addresses resources which will be needed to fulfill regulation, for example

- voluntary carbon accounting
- developing of guidance for managing information of building products
- pilot projects and testing practices
- ensuring benefits of Building Informational Modelling by tools and guidance

- education for designers, contractors and producers and other stakeholders. (Bionova 2017.)

European Union's Emission Trading Scheme (EU ETS) is indirectly connected to building sector, because it covers industry sectors such as steel works, production of aluminum, metals, cement, lime, glass and ceramics, which are important building materials (European Commission 2016). CO2 emissions from those industries are focused by EU ETS works on cap and trade system. In principle, it means that companies in certain sectors have emissions cap, which limit the amount of emissions that companies under the cap are allow to emit. Companies can buy their emission allowances to cover their GHG emissions. (European Commission 2016.)

4.2 Stakeholder aspects

The main principle in the real estate sector is to create a long-term value of an asset (ULI 2016). The real estate sector, including residential and commercial buildings, is a significant source of GHG emissions, and thus potential sector for those who has interest to invest to environmental responsible targets (Vanags & Butane 2013). CSR issues have been seemed as an important part of business strategy also in this sector, and the main reasons for addressing responsibility issues among the real estate companies are ensuring and creating a good image of a company and managing risks. (KTI 2017, 6.)

In Europe, owners and users in the real estate sector has been taking more and more proactive approach on sustainability issues and taking such issues into account in their investment processes and rental requirements. It is recognized that property investors of indirect and equity investment has been already setting sustainability standards and climate change criteria in asset allocation as well as investing green real estate funds, and effecting on development of sustainability benchmarks and tools etc. Investors of direct investments has been also set minimum sustainability standards for investments and putting effort for understanding climate risks and opportunities, and they have been implementing responsibility policies is with suppliers and sub-contractors. (IIGCC 2013, 13-14.) Key risks and opportunities of real estate investments from climate change and sustainability has seemed to be climate,

energy and building regulations, users demands, active building management, sustainable design and refurbishment and changing weather conditions (IIGCC 2013, 6). According Smith (2013, 4) climate change related risks which can occur by in-efficient property stock are growing prices of electricity and water, losing tenants, losing value of property, rising material prices by carbon taxes and tightening regulations due to low-carbon and low energy building targets of European Union.

The current European Union's directives which have the most powerful impact on real estate markets are Energy performance of building and Energy efficiency directive (IIGCC 2013, 7). Various environmental performance certificates give stakeholders an opportunity to evaluate sustainability of construction projects (Rogmans & Ghunaim 2016, 604). Voluntary environmental performance certificates, especially LEED and BREEAM has continuously coming more and more important for real estate owners, and regulators are acting in many countries for creating standards for sustainability measurements (KTI 2017, 8; Rogmans & Ghunaim 2016, 604).

Urbanization is a current mega trend, which brings opportunities and challenges in the real estate sector. For example, in Finland, around 75 % of real estate market is located in Helsinki metropolitan area, where also 27 % of the population and 31 % of the work places are located. (KTI 2017b.) As claimed in chapter 2, cities have started to set their own climate targets based on national and international goals. Main decision of climate change actions in cities and municipalities are energy sources of energy production plants, building guidance, area and traffic planning. A great number of Finnish municipalities are involved into toward carbon neutral municipalities–project. Municipalities involved into the project have committed to decrease 80 % of their GHG emissions. (SYKE 2014.) The Ministry of Environment published procurement criteria for low carbon building, which aims to promote low carbon procurement processes in public projects. The guide includes instructions for procurement of design-services, procurement of material and equipment, procurement building work and different types of project. The focus of criteria is in the life cycle aspect. (Ministry of the Environment 2017b.) Low carbon cities has also been addressed in National urban develop-

ment plan, including low carbon cities, resource efficiency, circular economy, wood construction, sustainable food systems and innovative sustainable public procurements (Ministry of the Environment 2017).

4.3 Reducing GHG emissions in the construction sector

This chapter discusses on reducing GHG emission from activities of scope 1, 2 and 3 which were presented in 3.2. The most significant GHG emissions sources are considered.

4.3.1 Scope 1

Scope 1 emissions refers to direct emissions from company's own activities as discussed in 3.1. Fuel for construction vehicles has been found as the most significant source of direct emissions in the construction sector (Acquaye & Duffy, 2010, 790). Transport and vehicles has been claimed to contribute 51% of direct GHG emissions in the building construction (ClimateSmart 2013). According to Acquaye & Duffy (2010, 790) most significant construction activity which causes the biggest share of direct emissions is structural works by contributing 76 % of direct GHG emissions. Secondly, ground works has been assessed to cause around 10 % of direct emissions in the sector. In addition, it is studied in England that 15 % of GHG emissions from construction processes is from business travel. Direct emissions from business transportation can be cut by allowing only fuel-efficient company cars and leased cars, reducing flights by preferring rail ways and reducing conferences. (Construction Product Association 2012, 41.).

Reducing fuel use in construction equipment is suggested strategy toward carbon emission reductions (Wong & Zapantis 2016). Methods for reducing vehicle related emissions can be fuel switching to renewable low carbon fuels, equipment selection to more fuel efficient and maintenance of vehicles. Optional fuels and caused climate impacts are presented in table 3. Recognized reduction activities are also drivers behavioral change of drivers by training and eco-driving campaigns, minimizing unnecessary loads, speed and acceleration optimization, and for example, avoidance of unnecessary braking and engine idling. (Construction Product Association 2010; US EPA 2009, 12; Acquaye & Duffy 2010, 790.)

Table 3 Emissions for fuels used in working equipments and vehicles.([1]Lipasto 2016; [2]TIlastokeskus 2018)

On-site equipment fuels	**gCO2-eq/kWh**	**Vehicles (personnel traffic)**	**gCO2-eq/km/person**
Diesel[1]	261	Diesel[1]	83
Petrol/gasoline[1]	360	Petrol/gasoline[1]	94
LPG[1]	234	FFV[1]	18
LNG[2]	201	CNG (40 % bio) [1]	41.2
Electric [1]	0	Electric cars[1]	0

* Electricity is emission free in use (considered in the scope 2).

4.3.2 Scope 2

On-site and off-site energy use, which are caused by supporting off-site human activities such as offices, are significant sources of GHG emissions and potential for GHG emissions reductions. (Pöyry *et al.* 2015, 361; Hong *et al*. 2014, 254). Wong *et al*. (2013, 121) presents three strategies for reducing scope 2 carbon emissions; reduce electricity use in plants and machines in use of construction site, reduce electricity use in premises, for example in offices and warehouses, and reduce purchased heat in use of construction site and property.

Heating demand contribute 70 % of energy use in construction site (Teriö & Hämäläinen 2015). Possible heating methods are district heating, electric heating, liquid gas and oil. Thus, it is important to choose the most suitable and energy efficient heating methods for each working phase, but also ensure a proper airtightness of covering (Hämäläinen 2015, 82). It was studied in a one apartment house construction site in Finland that the biggest share of electricity used is for lightning and equipment (70 %), additional heating (approx. 20 %) and site barracks (10 %) (Hämäläinen 2015, 58). Practices for improving energy efficiency on a construction site are avoidance of unnecessary lightning and using LEDs, energy efficient site barracks and metering, reporting and communicating about energy consumption (Construction Product Association 2010). In addition, seasons have significant impact on energy consumption due to varying weather conditions and heating demand (Teriö & Hämäläinen 2015).

4.3.3 Scope 3

Analysis of an apartment house construction process in Sweden shows that 84 % of climate impact of a construction process can be contributed from construction materials. Concrete, mortar and reinforcement accounted half of climate impact of the project and wood products, boards and sheet metal 20 %. The biggest amount of indirect emissions has been studied to be based on production of steel and concrete (IVA 2014, 12). Most used materials and their climate impacts are presented in table 4.

It has been studied that emission mitigations targets in the construction sector should aim to decreasing the amount of carbon intensive materials and the transportation distances of the materials. (Yu *et al*. 2016, 212.) Also, Hong *et al*. (2014, 257) discusses of significant contribution of material selection to indirect GHG emissions of the building construction. Selection of low carbon materials has seen to be an efficient way to decrease emissions. (Hong *et al*. 2014, 257; US EPA 2009, 25.)

Table 4. Construction materials and carbon equivalent emissions (VTT 2013)

Product	**gCO2-eq/kg**
Non-ferrous metals, stainless steel	1100
Non-ferrous metal, aluminium	3250
Concrete, cast in-situ	150
Brick	160
Glass	540
Insulation, mineral fibre	1030
Gypsum plaster	420
Bitumen	800
Hollow-core slab	180
EPS	2410
Filler	360

Gonzalez & Navarro (2005, 908) claims that selection of low carbon materials can lead to 27 % CO_2 emissions reductions in the project level. Replacing carbon intensive materials, especially concrete by wood would result lower embodied emissions. According to Pasanen *et al*. (2011) wood structure can reduce 28 % GHG emissions of construction phase of a

building compared to concrete. Recycled and recyclable construction materials are as an option to replace carbon intensive materials. Use of recycled materials compensate emissions caused in material production phase. Steel and metals are globally recycled materials. (Koskela *et al*. 2011, 20.) Concrete is the most used construction material. Cement industry has been in pressure decrease and eliminate CO2 emissions and increase energy efficiency due to huge contribution to total human caused CO2 emissions and tightening legislation and carbon taxes, and hence new production methods and formulas has been created in the industry (Imbabi 2012 *et al*. 194). Recycled concrete can be already used in backfill and as a substitute of new concrete (Hajek 2017, 212).

Buildings have to fulfill technical, functional and aesthetical quality requirements under the budgets of construction. While ensuring that projects will meet baseline requirements, building designers have an opportunity to decrease climate impacts. (IEA 2016, 8; Gonzalez & Navarro 2005, 908.) Understanding embodied impacts of building in a design phase is coming more important, since and share of embodied emission of production and maintenance from life cycle's GHG emissions is increasing due to energy efficient buildings. (IEA 2016, 9.)

Designer has the chance to influence on embodied emissions during the different stages of design. In the pre-design phase designer can put an effort for defining of general project goals and building performance targets with clients. Assessment of alternative construction methods and main building materials in an aspect of embodies emissions should be carried out in the preliminary design phase. Comparison of alternative building materials in a component level and product group level should be done in design development phase. (IEA 2016, 15.) Koskela *et al*. (2011, 40) suggests Building Information Modelling (BIM) will be a significant tool in the future for designer to assess environmental impacts. When project is in a stage of preparation of contracts and tendering, it is also important to include emission targets and requirements to contracts and tender documents as well as require Environmental product declarations or LCAs from product and material manufacturers and suppliers. (IEA 2016, 15.)

The Green Construction Board (by UK government) has presented a low carbon roadmap, which aim is to reduce GHG emissions in the whole construction sector. In this model, the key priorities for reducing embodied GHG emissions of the sector concern to carbon measurement and reporting, promoting EPD practices for building products, databases for building benchmarking, training of professionals to deal with GHG emissions and promoting research and new models for low carbon supply chain as well as promoting research in efficient material processing and promoting new product innovations as well as carbon capture as storage project. (GCB 2013.)

It has been suggested to obligate material suppliers and contracting firms to serve the GHG emissions data of their products, recycled materials as well as new materials, based on metrics e.g. kg/CO2 for clients and building designers who has opportunity to choose low emissions embodied materials. (Acquaye & Duffy 2010, 790.) Emission data sharing and collaboration both upstream and downstream partners is essential for finding the hotpots of emissions and choosing strategies to reduce environmental impact in a supply chain (Dadhick *et al*. 2014, 280).

GHG emissions of construction products life cycle can be cut down by efficient manufacturing, appropriate handling, minimizing waste during product's life cycle, sustainable logistics and warehousing. Also, optimizing transportation routes is also a way to improve efficiency and increase savings (Dadhick *et al*. 2014, 273). Emissions which are associated to building materials can be decreased by buying locally produced materials, when transportation distances can be reduced (US EPA 2009, 25). Promoting the choosing local material suppliers has been pointed as efficient way to decrease material related emissions (Hong *et al*. 2014, 254).

4.3.4. Low energy buildings

Energy consumption in buildings is the biggest source of GHG emissions in Finland; 38 % of all consumed energy is contributed from heating demand of buildings. (Motiva 2007.) Site selection, energy system selection and design decisions determine the level of energy demand of a building. Five stages (shown in figure 7) may be considered while designing

low energy buildings; reducing heat losses, reducing electricity consumption, exploiting passive solar energy, controlling and displaying energy consumption and selecting energy source.

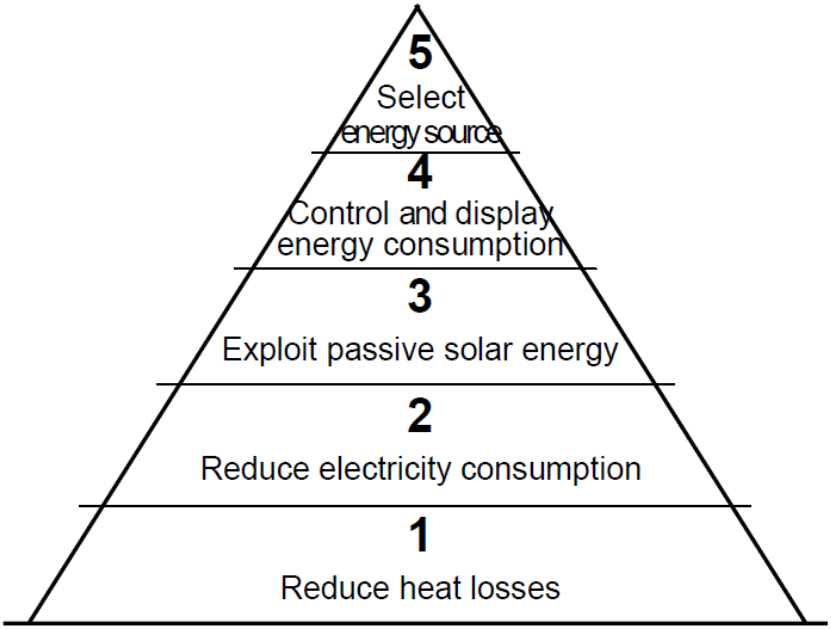

Figure 7. Planning energy efficient buildings. (IEE 2012.)

There are various concepts for low energy buildings. Low energy house has 25-50 % lower energy demand compared to minimum level of regulations whereas so called passive houses have a very low space heating and primary energy demand. Passive house is concept with very low energy demand by daylight and natural ventilation systems as well as renewable energy supply. There are also zero energy and zero emission building concepts. Zero energy building produces at the annual level renewable energy as much as the building consumes. Zero emission means that renewable energy is produced as far as it offsets GHG emissions from material production and energy consumption. (IEE 2012, 5-6.)

4.4 Challenges in the construction sector

Giesekam *et al*. (2018) discusses about emission reduction targets of UK's construction sector, where a small number of construction companies have aims to be carbon neutral or net-

positive in the future. A small number of companies have committed to international or national commitments, such as fighting against the 2 C temperature rising. Many of firms in UK is disclosing their scope 1, 2 and 3 emissions, and they have emissions reduction target for scope 1 and 2, and in some cases for scope 3. Reduction targets are generally short-term targets excluding scope 3. (Giesekam *et al.* 2018, 109.)

Several challenges have been found for setting emission reduction targets for companies in the construction sector, for example divided roles and responsibilities, longevity of asset, high share of indirect emissions from value chain (scope 3), use of imported and carbon intensive materials when responsibility of emissions spread in the supply chain, misaligned boundaries for reporting, role in setting boundaries for other industries. Analyses of the construction sector tend to focus mainly on operational phase of buildings. Outputs of this sector can be buildings or infrastructure projects etc, which means that outputs are very diverse. Divided roles are associated to a big number of actors, including design, delivery, ownership, use and maintenance have impacts on sector outputs. Clients can set targets for embodied and operational carbon emissions but making such targets possible depends highly on a designer and contractor team. In the construction sector, the approach to projects is usually cost-driven while whole life cycle carbon reduction arguments are seen to be challenging to validate to clients when they have not set any targets for reduction. (Giesekam *et al*. 2018, 110) Omitting scope 3 emissions from the reporting may lead to the limited emission reduction targets (Giesekam *et al.* 2018, 109).

Circular economy and material efficiency trends have been commonly rising in the building sector. However, it is observed that carbon footprint is not as yet a commonly used environmental performance indicator in public or private building projects (Kuittinen 2015, 156). Missing of legislation for calculating embodied carbon footprint of buildings can be seen as a challenge in building sector. Drivers to calculate embodied carbon footprint of buildings are environmental certifications or rating schemes such as BREEAM and LEED and business opportunities, design criterion and cost savings (De Wolf *et al.* 2017, 76). Consistency in approaches to the embodied carbon footprint calculation will be needed before buildings' embodied emissions are included to regulation. There is still a lack of consistency and a lack

of criterion for calculation methodologies also in the global level, which means that results of embodied emissions are not comparable with each other. (De Wolf *et al.* 2017, 78.)

4.5 Conclusions of the theory review

The aim of the literature review was to define GHG emissions of a construction company and find the most significant emission sources and the ways to impact on those sources. ENCORD standard was used as a frame work. Stages of building's life cycle as defined by EN 15987 standard can be connected to a construction company's GHG emission as well as construction processes as follows (figure 8).

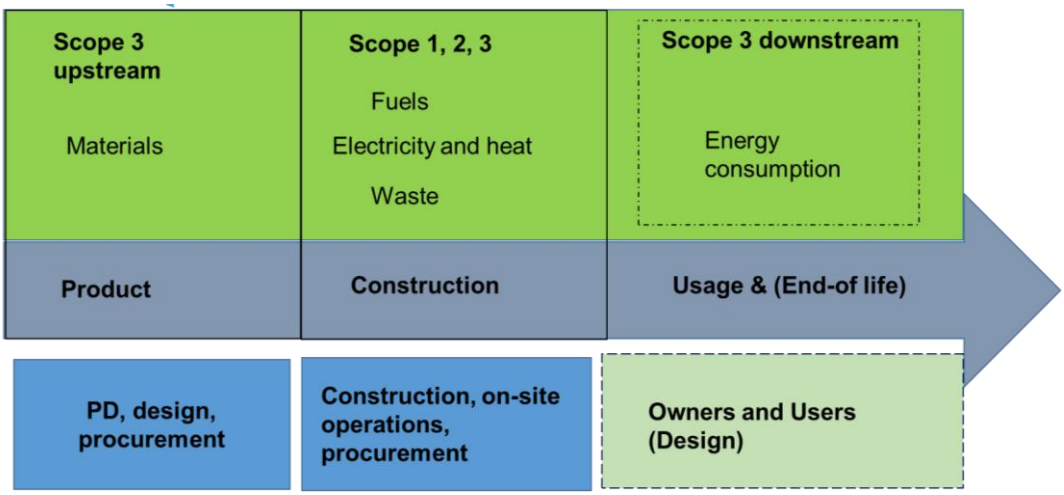

Figure 8. Relationship between most significant emissions sources of scope 1, scope 2, scope 3 at a construction company level and GHG emissions of product's life cycle. (Idea from WBCSD 2011, 6)

Construction includes processes from project development and project planning to design phases to procurement and construction activities, which have impact on caused GHG emissions. Planning and design phase has a great influence on GHG emissions by design, material and equipment decisions while procurement can obligate suppliers to serve environmental data of products, EPDs etc. Construction site related activities cause direct GHG emissions from fuel usage in construction equipment and vehicles and indirect emissions from electricity and district heat usage and from waste management as an indirect emission source. Business transportation has been also pointed to be a great emissions source. In figure 8, there are shown the most significant emission sources of a construction company divided by

scope 1, 2 and 3. Core strategies found by literature review to reduce such emissions have been drawn up in table 5.

Table 5. GHG emissions sources and emissions reducing methods found by literature review.

Scope 1	Scope 2	Scope 3
On-site fuels • fuel switching to renewable fuels • maintenance and eco-driving training • electric equipment/vehicles	**On-site electricity** • lightning by LEDs • energy efficient barracks • electricity from certificated renewable sources • metering ja reporting	**Material production & Material transportation** • searching low carbon materials • searching recycled and/or recyclable materials • preferring close produced materials
Traffic (vehicles owned by company) • fuel switching to renewable fuels • electric cars	**On-site district heat** • reducing need of heating by optimizing heating methods	**Waste** • promoting recycling and reuse
		Energy consumption of the operational phase • planning low energy buildings

There are six emissions sources; on-site fuels, transportations fuels, on-site electricity, on-site district heat, materials and waste. In addition, low energy buildings in the operational phase is addressed as a strategy to reduce climate impacts since energy efficiency of building is affected by planning and design decisions and it is a significant source of GHG emissions in societies.

5 EMPIRICAL RESEARCH

5.1 Research methods used in this study

The research method of this study was qualitative research. Hirsjärvi *et al*. (2007, 157) presents that researchers use qualitative research method for reaching a holistic view of the research target. Aim of the qualitative research is find and point out a new phenomenon rather than repeat existing claims or facts. (Hiusjärvi *et al*. 2007, 159-160.) The most common data collection method for qualitative research are interviews, questionnaires, observation and documents. (Tuomi & Sarajärvi 2013, 71-73.) The chosen data collection method for this study was interview. Interviews were chosen since the aim of the research was to understand insights of interviewees and ask additional questions on demand.

Interview is defined as an arranged situation where interviewer presents questions and marks answers up for analyzing (Tuomi & Sarajärvi 2013, 71-73). There are various benefits related to interview as a research method. It is flexible; researcher has ability to control research conditions and data collection during the interview. It offers a possibility to interpret answers more widely. Interview can be beneficial method when it is intended to highlight the active participation of respondents, if area of research is unknown or responds are intended to locate to larger context or it is known that topic of research will get complex responds. Interview is also justified method when it is intended to clarify or deepen received responds. In addition, respondents will be easily reached after interview on demand. On the other hand, interviews are much more time- consuming compared to questionnaires. Respondents can prefer answers which are social appropriate, what decrease reliability of the data. Situation, interviewer as well as interviewee cause sources of errors. Data has been bound to context and situation, and thus results should not be overgeneralized. (Hirsjärvi et al. 200-204.)

Research interviews are typically divided to the three groups; structured interview, semi-structured or thematic interviews and open interview. Now, semi-structured interview was chosen as a research method. Characteristics of thematic interview are formulated themes without accurate order and form. It can be used as a qualitative or quantitative research

method. Questions in thematic interview should support the research problem. Themes should build frame work for research. In this study, person interviews, pair interviews as well as group interviews were hold. (Hirsjärvi et al. 200-204; Tuomi & Sarajärvi 2013, 75)

5.2 Data Collection

Data for this study was collected in semi-structural interviews. 17 interviewees participated in total. Majority interviews were conducted face-to-face and three of interviews were conducted via Skype Conference call. . The interviews were decided to carry out for two target groups; real estate investor companies and cities/municipalities as these both are identified as important stakeholder of the company. Interviewees were contacted by email during February-April 2018. Interviewees had received questions before interview sessions. Interview questions are shown in appendix1. All of interview sessions were recorded. Questions for interview were created by based on the theory review. First questions are background questions about organization's climate targets and following questions about buildings' and construction companies' role on such targets.

5.2.1 Real estate investors

Contacted real estate investor companies operate mainly in Helsinki metropolitan. All of target contacts were not reached. However, seven out of nine companies answered for interview invitations. In some cases, contacted potential interviewees forwarded and suggested other expert in their company, who was expected to have wider knowledge of themes of interview. In total, there were six individual interviews and one pair interview with real estate investors. Background information of interviewees is shown in table 6.

Table 6. Interviewees in Real estate investment companies

Interviewee(s)	Company	Date	Length/minutes
Portfolio manager Portfolio manager	Pension fund	7.3.2018	56:53
Real Estate Manager	Real estate fund	20.2.2018	37:07
Real Estate Investment Director	Pension fund	27.3.2018	41:01
Sustainability Manager	Real Estate investment	27.3.2018	45:35
Construction Manager	Pension fund	26.3.2018	50:04
Real Estate Development Director	Real Estate Investment	9.3.2018	41:22
Property Development Director	Pension fund	13.4.2018	47:49

5.2.2 Cities and municipalities

The cities and municipalities were chosen based on markets where the company operates and which cities or municipalities are clients of the company. Interviewees in cities and municipalities were contacted based on their expertise. All of target contacts were not reached. However, nine out of twelve contacted people participated. Contacted potential interviewees forwarded interview invitations to other experts in the organizations on demand. There were six individual interviews and one group interview. In total, interviewees from five different cities/municipalities participated. Interviewees are listed in table 7.

Table 7 Interviewees in cities and municipalities

Interviewee(s)	**Date**	**Length/minutes**
Environmental Specialist	26.2.2018	38:25
Liaison Manager	12.3.2018	44:07
Senior Environmental Specialist	13.3.2018	36:58
Energy and climate specialist	26.3.2018	50:04
Project Director	29.3.2018	54:47
Environmental Specialist Environmental Specialist Chief Energy Specialist Project Planner	24.4.2018	1:15:16

5.3 Data Analysis

Tuomi & Sarajärvi (2013, 121) handles method for data analysis. A one method is to three-stage process including 1. simplification 2. grouping 3. abstraction. Data analysis can be also divided to smaller stages as presented in figure 9. Recordings were listened and transcribed after interview sessions. Transcribed interviews were carefully red by marking the relevant quotations relative to the study. Relevant quotations were grouped under themes and converted to simplified forms. Simplified forms were categorized, and categories were further joined to clusters. An example of the data analysis is presented in appendix 2. In some cases, data analysis can be quantified after clustering. However, quantifying is problematic when it comes to qualitative research since amount of data is usually too little for sharing additional information by quantifying. (Tuomi & Sarajärvi 2013.) In this research, some themes of data were quantified in purpose to point out how significant some phenomes were among respondents.

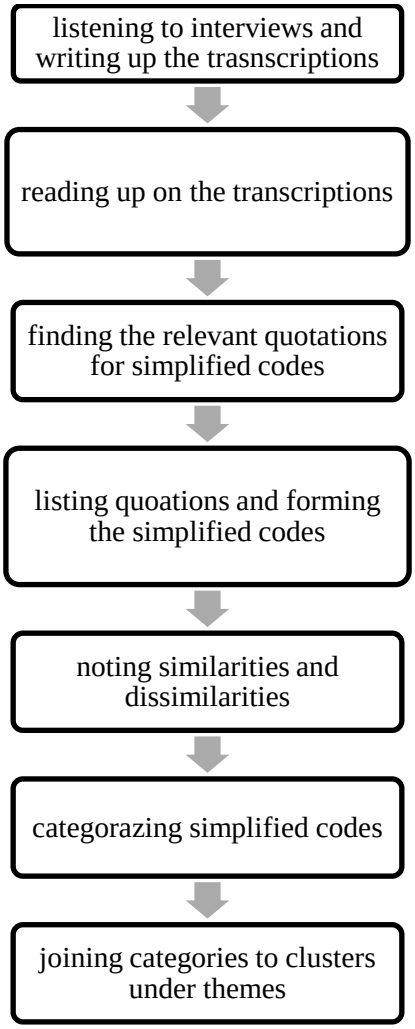

Figure 9. Stages of Data analysis used in this study. (Modified from Tuomi & Sarajärvi)

6 RESULTS

Results from the empirical research are presented in this section. The target of interviews made for this study was to find climate targets and climate insights of customer groups and find how construction companies can respond to those targets. Result are presented separately for two customer groups, real estate investors and cities and municipalities.

6.1 Real Estate Investors

Interviewed companies had various climate and environmental targets. Some of those targets were part of reporting whereas some of targets were more like unofficial aims. Official emission reducing targets which were found are presented in table 8.

Table 8 Official targets of real estate investor companies found by interviews.

Target under reporting	Number of responds (max. 7)
energy efficiency/energy consumption of property stock	7
renewable energy	2
waste sorting, operational phase	3
carbon footprint, operational phase	3
carbon footprint, life cycle	1
water use, operational phase	2
environmental rating system (LEED and/or BREEAM)	3

All of companies had target to decrease operational energy consumption and increase energy efficiency of buildings. Other notable targets were to increase waste sorting in operational phase of properties, decrease operational carbon footprint and increase amount of buildings with environmental certifications. In addition to official climate and environmental targets of companies, unofficial targets and priority areas were found. Such areas were, for example, promote waste management and recycling in properties, awakening customers' (users) awareness of the environmental aspects and increasing utilization of renewable energy solutions.

According to interviewees, climate and environmental targets of companies were based on global and national voluntary coalitions and agreements as well as environmental responsibility politics and values inside the companies. Interviewees had also recognized that personal values and personal aims were reasons to impact on climate change, as follows; *Inside the company and among the people here, we want to act like this--, properties cause a great part of CO2 emissions. We are a big actor, we have to give a lead and do environmental acts. (I1.)* Customers' interests were also reasons for target setting. It was stated, for example; *Area of business and business environment is moving toward more aware of importance of environmental issues – Consumers' and customers' expectations and values are drivers in companies. (I4)*

Interviewees were asked about environmental interest areas of their customers (users). It had been noticed that especially users of commercial buildings are interested in energy consumption and energy savings, renewable energy solutions, waste sorting possibilities, water consumption, environmental rating systems (LEED and BREEAM). When it comes to energy consumption, interviewees claimed that users of their buildings are interested in monitoring energy consumption and possibilities to decrease their energy consumption. It was claimed that users have intended to promote their image as responsible actor by choosing energy efficient properties. Several respondents were analysed that users are motivated to do energy efficiency improvements if those improvements do not increase costs. In the rental residential sector, according to one respondent it had been noticed that there was not any environmental or energy aspects which would affect on renting decisions at the moment. Factors that currently has an effect are locations and services in the neighbourhood.

Each of interviewees had a view of growing pressure to decrease climate impacts in the real estate sector. The pressure to mitigation actions was assumed to come due to the growing awareness of the users, from real estate investors as well as from national regulations. On the other hand, interviewees had found that global warming and climate change is a threat that pressure to mitigate climate impacts in real estate sector.

Impacts of Environmental responsibility aspects on choosing partners

Interviewees were asked whether environmental responsibility aspects have impact on choosing partners or contractors. The accurate requirements when it comes to climate strategy of partners did not directly occurred. Two topics about choosing partners recurred in all of responses;

1. Responsibility as a minimum precondition.
2. Bad reputation due to reasons such as criminality and breaking the regulations as exclusionary factors, for example; *If one has done some environmental offence, there is no chance (of being a partner). Or, if one has act in irresponsible way according to the media, most likely we would not operate (with that company). (I5.)*

Several interviewees also described that requirements which had been set for construction contractors or other suppliers included also environmental management system and recent references. Ability to share data of environmental impacts of construction operations on demand, awareness of environmental impact as well as aims to decrease environmental impacts had been general requirements for suppliers in several companies. One of interviewees stated they are already aware that large companies, such as Skanska, have done improvements to promote environmental responsibility in its activities. On the other hand, it was also observed by several interviewees that at the moment no one of construction companies differentiate oneself by decreasing environmental or climate impacts.

Defining GHG emissions of buildings

One theme of interviews was GHG emissions of buildings. Questions handled reporting methods and scope of defining, advantages, challenges, need of reporting and other views concerning GHG emissions and carbon footprints of life cycle of buildings. In table 9 there is shown how companies reported and defined GHG emissions of owned and constructed properties.

Table 9. Scope of defining GHG emissions of properties

Reporting GHG emissions of buildings	Number of responds
Annual GHG of whole property stock, operational phase	2
Annual GHG of each piece of property, operational phase	2
Life cycle GHG emissions of new buildings	1
Calculation methods for LC GHG emissions under develop	2
GHG emissions are not currently defined	1

In one of the companies, carbon footprints of new buildings had been determined using the LCA. In addition, two of companies were currently developing methods for measuring a carbon footprint of a construction phase. Five other companies had measured annual GHG emissions from operational phase of either whole owned property stock or each property. One of companies did not measure GHG emissions from operational phase of building. It was assumed however, that in the near future carbon footprint will be measured. Several interviewees assumed that carbon footprint of life cycle of new building will be measured and considered in the future. In commercial sector, it was seemed that environmental rating systems, LEED and BREEAM, would be relevant tools in determining and mitigating climate impacts during life cycle of buildings.

Several companies were aware of future tighten building regulations about GHG emissions. Interviewees were asked whether they could find advantages of measuring carbon footprint or GHG emissions of life cycle of buildings. Some advantages and possibilities were found, such as; ensuring responsible image of company, ability to meet future building regulations. It was also stated that carbon footprint measurement could bring ability to point out to how solutions and decisions contribute to carbon footprint of buildings for the involved parties and thus arouse dialogue between parties who has possibility to effect on construction products and methods during construction projects. It was stated by one interview that data of carbon footprints could also help local authorities to pay more attention to carbon footprints in area planning.

Recognized or supposed reason why LC GHG emissions for new buildings were not measured were; GHG emissions of operational phase were seem as more important or more relevant target to impact in owner's point of view. It was also stated that measurement

(kgCO2eq) is too complex and not enough concrete; CO2eq emissions are not connected to €/CO2eq. Also, lack of commonly accepted standards and calculation methods and lack of experiences seemed to be problematic issues. Company, which had measured life cycle GHG emissions of building, had faced challenges with reclamation of results and starting dialogue with parties, local authorities etc.

Insights to challenges in reducing climate impacts

Interviewees were asked about challenges they had faced or observed relating to reducing climate impacts in the real estate sector. Various insights of challenges and problems occurred. In general, broad scale of different actors and investors seemed to be as a challenge; real estate investors have various targets and motives, for example the length of ownership. Construction and real estate sector was characterized as a conservative sector with slow adaption of new trends and techniques. Challenge was also a huge load of available properties and existing building with lower energy efficiency compared to new buildings. Profitability of solutions such as renewable energy investments and low carbon materials were seemed as a challenge. However, several respondents had a view of mitigation of climate impacts is rather like a business opportunity than a challenge.

Interviewees also assumed that there might be challenges with reaching zero energy building and ensure comfort and safety of living conditions. It was said that customers are interested about energy consumption, and companies are also expected to report energy and carbon emissions from properties. However, data of energy, waste and water consumption is available from various, non-integrated, sources and thus, data collection was found to be challenging. High level of GHG emissions from energy, district heat and electricity production were also faced as a problematic issue since emission factor of energy production increases computational emissions when owners report GHG emissions from the real estate stock (GHG Protocol scope 2 emissions).

The Role of construction companies in reducing climate impacts

Interviewees assumed what kind of data and/or solutions they supposed to be needed in decreasing the climate impacts of buildings and how construction companies can respond to their climate targets. The main topics which were found by data analysis are energy solutions, space flexibility, construction site activities, traffic and data of environmental impacts of construction products. Categories of answers are divided to related scopes of GHG emissions sources in table 10. Other aspects, which cannot be included to emission scopes or not owned by a construction company are included under the topic "other". The topic of energy efficiency seemed to be the most significant, and then material aspects and space flexibility.

Table 10. Actions and focus areas for construction companies divided to scope 1-3 and other aspects. (f=number of responds)

Scope 2	Scope 3	Other
Construction site • data of climate impacts of construction site activities (energy consumption, waste management, use of renewable electricity) (f=2)	**Materials** • data of construction materials (EPD etc.) (f=3) • acknowledgment of life cycle impacts of used materials and solutions (f=2) • promoting use of low carbon materials (f=3)	**Traffic** • awareness of changes in transportations; joint use cars, electric cars etc. (f=2)
	Energy efficiency • promoting/increasing renewable energy solutions (f=3) • life cycle assessment for energy solutions and HVAC (f=3) • Optimized energy consumption by control of circumstances (f=2) • targets to energy efficiency (f=4) • ensuring that energy efficiency targets will be reached in the operational phase (f=1)	**Space flexibility** • alteration of use of spaces is easily performed without huge remodeling (f=3) • alteration of use of buildings (f=1)

It was also assumed that data of climate impacts from construction site activities will be desired. It was expected by the interviewees that construction companies should have data and knowledge of climate impacts of construction materials and building components and data of comparison alternatives solutions in an aspect of climate impacts; *Construction com-*

panies could help and bring out solutions and alternatives (material and construction products). It could be really and truly thought, which alternatives reduce the carbon footprint. (I5) Several interviewees recognized that when carbon footprint measuring is relevant they would need reporting of environmental impacts of construction products by construction companies. The interviewee from company which had started to measure carbon footprint noted that information about contribution of different construction products and solutions to carbon footprint are needed. Space flexibility was also recognized to significant area by interviewees when it comes to planning of buildings. Interviewees were also recognized that in some cases space flexibility has not been easily implemented even it was promised by contractor. It was also recognized by a one interviewee that remodeling of spaces should be overall made much more lightly.

6.2 Cities and municipalities

Climate targets of the cities

Interviewees used official strategies and agendas of the cities they represented while answering questions about climate targets. Interviewees had been participated to new area development projects or other pilot projects and thus they referred their responds from those projects.

All of concerned cities had strategies or agendas against the climate change. In general, such documents were called as a climate agendas or strategies or carbon neutral roadmaps. At the moment of interviews, a few of cities were updating their agendas, and hence the exact targets were not available. According to the interviewees, several cities had an aim to reach the carbon neutrality, which means, in this case, to cut GHG emissions 80 % and compensate 20 % of emissions from the 2005 level. There were also agendas for promoting resource efficiency and different sustainability frame works as well as the energy efficiency agreements.

Insights to carbon footprint accounting

Life cycle carbon footprint seemed as a topical issue in several cities. Several respondents assumed that life cycle carbon emissions of buildings will be required to be defined in new residential areas in near future and then regulated by regulations. Several cities had practised carbon footprints measurement in the area development projects and other pilot projects. Carbon footprints of buildings had been measured for a pilot studies and land disposition competitions. Interviewees were asked to assume the benefits of the data that buildings' carbon footprints would share. According to responds, data of carbon footprints could be used in controlling the construction and building materials. They had faced challenges related to carbon footprint accounting, comparability of results and limited resources for construction controlling. There was also challenges to determine the relevant phase during the construction project to require carbon footprint reports.

Insights to challenges in reducing climate impacts

Interviewees were asked about challenges related to mitigating climate impacts of buildings and the construction sector. Various type of responds occurred. The main topic of responds was limited capability to impact on the sector. It was found that requirements should be set by national legislation. There are not tenders if requirements are too high when it comes to, for example, wood construction requirements. There were also insights of the limited impact on controlling users of buildings. Challenges were also related to limited capability promote renewable energy, especially on-site solar energy due to cost-optimization. Also, existing buildings are as a great challenge due to huge load of empty properties and a low level of energy efficiency.

The role of construction companies in reducing climate impacts

The role of construction companies in responding the cities' climate targets was a one theme of data analysis. That theme was charted in the interviews by questions*:* are buildings and construction activities included to climate targets of the city and how can construction companies respond to climate targets of the city and what kind of solutions and/or data is needed

from construction companies. The most significant topics found by data analysis under this theme are; energy efficiency, materials and resource efficiency, traffic and fuels as well as communication and construction site activities. Main categories under those topics are presented in table 11.

Table 11 Actions and focus areas for construction companies divided to scope 1-3 and other aspects (f=number of responds)

<table>
<tr><th>Scope 1 & 2</th><th>Scope 3</th><th>Other</th></tr>
<tr><td rowspan="2">Fuels
usage of low carbon fuels (f=1)

Construction site
• sharing data of energy consumption (f=2)</td><td>Materials

• wood as a construction material (f=5)
• sharing the knowledge and data of environmental impacts of building materials (f=3)
• use of recyclable and recycled building materials (f=2)

Resource efficiency
• data of waste sorting and waste management practices (f=3)
• promoting the efficient use of materials and land masses (f=5)</td><td>Communication
• Communication of climate targets (f=3)
• bringing out innovative ideas (f=2)
• bringing out good practices (ideas of circular economy etc.) (f=3)</td></tr>
<tr><td>Energy
• promoting renewable energy solutions(f=3)
• setting high targets for energy efficiency (f=2)
• efficient use of space (f=2)
• ideas of smart buildings and areas (f=3)
• flexible and remodified HVAC & automation systems (f=2)
• life cycle assessment for energy systems (f=2)</td><td>Traffic
• ensure preconditions to promote low emission traffic (f=3)
(electric and biogas transportation, light traffic, use of joint use cars)</td></tr>
</table>

Energy efficiency actions concerned mainly to the new residential areas, and main categories were related to promoting renewable energy solutions and bringing out smart building ideas. Interviewees highlighted the importance of environmental impacts of construction products and materials. Cities/municipalities had also targets to promote wood as a construction material. It was also expected that construction companies should have data and knowledge of

construction materials and products. It was found also that several cities and municipalities had a target to grow recycled and recyclable construction materials.

Several interviewees also highlighted that they are interested about how companies have decrease climate impacts during the construction phase. Waste sorting and waste management occurred most often, as well as importance of promoting the use of left over materials and land masses. Two of interviewees were interested about the energy consumption during the construction time.*). I'm interested about energy consumption of the construction phase. Is there any monitoring by construction companies – What is the most significant emission source..? (C4)*

Several interviewees brought up the issue of knowledge in construction companies of environmental impacts caused by planned solutions or construction activities. It had been illustrated the role of project planners, designers and contractors, for example; *another challenge is knowledge of energy solutions and construction materials. Knowledge among the contractors and designers. (C1)* It had been also found that environmental aspects would be highlighted also trough the construction time.

It had been found that it is important that construction companies communicate of environmentally good practices they do and bring out their environmental targets. Joint development was highlighted in several interviews. The role of construction companies in the new area projects was highlighted as developers and innovators who should do pilots and find innovative energy solutions together with other parties.

7 DISCUSSION

Two stakeholders groups of a construction company were considered in the empirical part of this thesis; real estate investors as well as cities and municipalities. While analyzing the significance of the results, it must be noticed that interviewees had not been informed and civilized beforehand or during the interviews about the construction company's abilities to reduce climate impacts. They had not been told about previous achievements either, for example about performed pilot projects. Thus, the responds for the interview questions were based on interviewees own experience and insights about the current situation and the maturity of the sector. Also, interviewees were expertise in different field of professionals and their positions in organizations they presented were not similar with each other, which affected on responds. Interview conditions were not identical either; both individual, pair and group interviews were held face-to-face as well as via Skype.

7.1 Findings relating to the literature

Schaltegger *et al.* (2014) stated that climate change has become as a part of companies' strategic planning. Interviewed real estate investor companies had various climate and environmental targets, which focused on the operational phase of buildings; increasing energy efficiency and reducing carbon footprint of the operational phase, promoting waste sorting and recycling as well as increase utilization of renewable energy. Masalskyte *et al.* (2014, 133) has found corresponding sustainability practices in the real estate sector. Energy consumption, water consumption and waste management as common focus areas in sustainability considerations have been stated also by Rogmans & Ghunaim (2016). Rogmans & Ghunaim (2016, 604) has also addressed real estate investors' growing interest toward environmental certificates.

It had been stated by Heidrich *et al.* (2014, 42.) that cities have developed their own climate change mitigation and adaptation strategies. According to the results, cities and municipalities in Finland have created climate strategies, and set targets for carbon neutrality. It has been found that cities have used the term of carbon neutrality for representing significant reductions of GHG emissions (Seppälä 2014).

Vilchez *et al*. (2017) presented that companies' stakeholders have a significant impact on companies' environmental practices. This was also found by this study since results showed that climate and environmental targets of companies were based on voluntary coalitions and agreements as well as environmental responsibility politics and values inside the companies. Personal values and personal aims and customers' interests were also drivers for target setting. It was presented that users of buildings have started to take sustainability issues into account in their rental requirements (Smith 2013). This reflected also from results especially in the commercial sector. It was found that users are interested in energy consumption and energy savings, renewable energy solutions, waste sorting possibilities, water consumption, environmental rating systems monitoring energy consumption and possibilities to decrease their energy consumption.

Overall it was found that companies assess that demand to reduce climate impacts in the construction and real estate sector is growing due to the growing awareness of users, investors as well as from more stringent regulations. Corresponding drivers were found in literature (IIGCC 2016). Also, Blanco *et al.* (2017, 638) discussed corresponding drivers to companies' carbon accounting.

It has been found that two of the main drivers for CSR activities in the real estate sector are ensuring good image of a company and managing risks (KTI 2017, 6). This correspond with the result that main environmental responsibility factors which have impact on choosing partners and contractors were responsibility of a partner and bad reputation as an excluding factor. In addition, environmental management system, ability to share data of environmental impacts of construction operations on demand, awareness of environmental impact as well as aims to decrease environmental impacts had been general requirements for suppliers in several companies.

Kuittinen (2015) presented that LC carbon footprint is not commonly used measure in private or public building projects, what reflected also from results. However, several companies assumed that carbon footprint of life cycles of new buildings will be measured and considered in the future. Importance of developing methods for managing carbon footprint of buildings life cycle was also presented by Kuittinen (2015). By cities and municipalities,

it was assumed that life cycle carbon emissions of buildings will be required to be defined in new residential areas in near future and then regulated by regulations, what was also stated by Ministry of the Environment (2017). Ensuring responsible image of company and ability to meet future building regulations were found advantages of defining carbon footprints for the investors, also ability to point out to how solutions and decisions contribute to carbon footprint of buildings. Challenges related to defining LC GHG emissions were for example lack of commonly accepted standards and calculation methods and lack of experiences seemed to be problematic issues. Such challenge was also recognized by De Wolf *et al.* (2017, 76). Divided roles and significant number of actors in the construction sector were also addressed as a challenge in setting carbon targets by in literature. Also, nature of the sector referring to cost-driven approached projects has found as a challenge (Giesekam *et al.* 2018, 110). Such challenge was also found by interviews.

Majority of customers' climate targets and climate insights about the role of construction companies refers to scope 3 GHG emissions, especially to energy efficiency of buildings and environmental impacts of construction materials. Importance of promoting the use of recyclable and recycled materials, and efficient use resources were also highlighted by cities. Importance to impact on scope three emissions was highlighted also in literature; in general a greatest share of caused emissions are indirect emissions of the value chain (Huang et al. 2009, 509). It had been found by KTI (2017) that energy efficiency of properties as well as usage of renewable energy sources are focus areas during next three years in the real estate sector. This reflected also by responds; categories under targets to energy efficiency and promoting renewable sources raise from responds. Several interviewees had found that when carbon footprint measuring is relevant they would need reporting of environmental impacts of construction products by construction companies. It was expected by the interviewees that construction companies should have data and knowledge of climate impacts of construction materials and building components and data of comparison alternatives solutions in an aspect of climate impacts. Corresponding actions were suggested also by Acquaye & Duffy (2010, 790) and Dadhick *et al*. (2014, 280).

Growing knowledge in the construction and real estate sector and growing environmental data of construction products have been addressed as main areas under development before

carbon footprint of buildings can be regulated by Building Code (Ministry of the Environment 2017d). For example, Bionova (2017, 37) had investigated that around 23 % of experts in the construction sector have skills in material related CO_2 emissions and are able to use it during projects. It was found also that several cities and municipalities had a target to grow recycled and recyclable construction materials. Wood structure is a biogenic carbon storage until the end of life of a product (Kuittinen *et al*. 2015). Cities and municipalities had also targets to promote wood as a construction material. Corresponding practices has suggested by Finnish Sustainable Communities network (2017).

Heidrich *et al.* (2014) discussed that cities and citizens have shared responsibility of climate change mitigation and adaptation, and implementation of climate change strategies requires involvement of third parties such as businesses, utility owners and industry sectors. Several cities and municipalities addressed importance of communication and dialogue of the climate and environmental targets and practices. Communication with internal and external stakeholders as a sustainability practice was also recognized by Masalskyte *et al*. (2015).

Concept of carbon handprint, which is relatively new approach to reducing GHG emissions by the companies' products and solutions, were handled in the literature review. It is relevant to pay attention that companies and other organizations can affect positively to their stakeholders GHG emissions. Construction and real estate sector has a great impacts on human caused climate impacts (Santamouris 2016). Hence, when construction sector put effort for reducing climate impacts caused by the value chain, those reduction has a significant impact on their stakeholders; customers and societies.

7.2 Suggestions for the company

Embodied GHG emissions from construction materials and products has been pointed to contribute great amount GHG emissions of the construction project. The first suggested action is to increase data and knowledge of used construction materials and products. According to the results, customer groups expected that construction companies are aware of environmental and climate impact of construction products they used. Importance of this will grow according to results due to the LCA practices and coming regulations Materials with

lower GHG emissions, recycled or recyclable materials or materials with low emissions transportation are suggested ways to decrease material related GHG emissions. Suggested action is to require environmental product declaration documents (EPDs) from suppliers. Especially wood construction materials were highlighted in the cities and municipalities. It was discussed in the chapter 4 that understanding embodied impacts of building in a design phase is coming more important, since and share of embodied emission of production from life cycle's GHG emissions is increasing due to energy efficient buildings. (IEA 2016, 9.) GHG emissions targets could be set for a projects and targets could be included to each phase of project. Designers have a significant role at defining design goals for building materials which impact on embodied emissions. Comparison of alternative building material and methods in an aspect of GHG emissions should be made in the early project planning phase. (IEA 2016.)

Construction site activities have significant GHG emissions caused by a construction company. It was discussed in chapter four that construction project causes direct emissions especially due to fuel use in equipment and transportation and indirect from energy use on site and premises. Waste is also an important source of GHG emissions. (Construction product association 2010.) Direct emissions (Scope 1) and indirect energy emissions (scope 2) caused by company's own activities are important to address in the climate strategy since such emissions are mandatory reported for example by standards such as ENCORD and reporting schemes such as Carbon Disclosure Project. According to the results, several customers also assumed that importance of managing construction site activities will grow, for example, measurement of construction site GHG emissions and data of GHG emissions reducing activities.

As discussed in the chapter 4, it was suggested to meter energy efficiency at the construction site. According to ENCORD, scope 1-2 emissions sources including fuel use in projects, premises and vehicles owned by a company as well as electricity and imported heat used in projects and premises should be monitored and included to reporting. Especially heating methods should be guided to use district heat instead of oil and electricity. Energy efficient barracks and LED lightning is justified to use as a rule. Fuels for vehicles and equipment owned or controlled by companies are suggested to replace with renewables. Eco-efficient

driving training has also been pointed out to be a way to decrease fuel usage. (Construction Product Association 2010; US EPA 2009, 12; Acquaye & Duffy 2010, 790¸)

The third suggested action for the climate strategy is setting high-level energy efficiency targets and promoting energy efficiency and renewable energy sources in company's products through planning decisions. Buildings are not owned by a construction company after the beginning of the operational phase. However, project planning and design decisions determine level of energy efficiency (IEE 2012). Based on the interview results, customers in the real estate sector climate targets are about to reduce operational energy consumption and hence operational GHG emissions of real estate stock. It was also found that users of buildings are interested in energy consumption and monitoring it. Importance of grow energy efficiency of was also addressed in regulative aspects. According to results, customer appreciate bringing out ideas of the renewable energy solutions, optimizing energy consumption by building automation systems and smart technologies. It was also pointed out that setting energy efficiency targets and understanding decision made in the planning phase are important matters in customers' point of view.

The fourth suggested action for the strategy is promoting life cycle assessment for carbon footprint, what also refers to the other suggested actions. Importance of LC Carbon footprint accounting was highlighted both in literature review and interview results. Life cycle approach is focused in routemap of Ministry of The Environment and in the procurement criteria for low carbon building (Bionova 2017; Ministry of the Environment 2017b). Based on interview results, customer groups supposed that importance of understanding life cycle's climate impacts of building will become more important. It was seemed as a challenge that commonly accepted standards for defining GHG emissions are still missing. However, it is suggested to be aware of development. It was noted by customers that equipment and material solutions impact on GHG emissions and energy consumption should be determined and LCA tools. Hence, suggested action is to increase the knowledge of life cycle assessment. EN 15978 Standard for Assessment of environmental performance of buildings presented approach for the life cycle consideration. It addresses construction materials, processes and services during the life cycle.

Communication is a recognized sustainability practice in the real estate sector, which is suggested to be included to the climate strategy based on the interview results. Fist, communication of company's climate targets and practices can arouse customers' interest in climate change aspects. Communication of sustainability practices was found to encourage stakeholders to involve into sustainability practices. This was found interview results of cities and municipalities. It was stated that construction companies could bring out good practices, for example concerning circular economy and environmental impact assessment tools which could have help cities and municipalities climate change actions. On the other hand, it was also stated by real estate investors, that construction companies do not differentiate themselves by environmental or climate arguments at the moment. Hence, communication about climate targets and practices could also create an image of sustainable company. It would be also suggested action to communicate with construction material suppliers about company's targets to reduce GHG emissions from a supply chain and search for low GHG emissions materials. In addition, communication with internal stakeholders about the sustainability strategy is essential for reaching the targets (Newig *et al.* 2013).

It was presented in the chapter two that companies sustainability practices can be classified by maturity levels (Kasurinen 2017; Masalskyte *et al.* 2015). In the model, which were shown in section 2.3, there were three maturity levels. Now, maturity levels about corporate responsibility for sustainability are used for identifying maturity of suggested focus areas and related actions for the climate strategy. Now, levels 2 and 3 are used for describing reactive and proactive approach to climate change by the construction company in customers' perspective. Proactive and reactive actions are presented in table 12.

Table 12. Identified proactive and reactive actions of the climate strategy. (Model of levels from Kasurinen 2017)

Proactive *"long term license to operate among stakeholders"*	proactively promoting low GHG emission material alternatives setting GHG emission targets to design	proactively decreasing GHG emissions from sources by using renewable fuel and energy sources	minimizing GHG emissions by using LCA approach in building design	communication about climate targets inside the company awakening customers' interest towards sustainability and reducing climate impacts	ensuring energy efficiency targets will be reached in the operational phase
Reactive *"to build trust among stakeholders"*	growing knowledge of GHG emissions of construction materials EDPs form suppliers readiness to share data for stakeholders	fuel and energy consumption is monitored from sources waste management and efficient use of left over materials and masses data of climate impacts caused by construction activities	defining Life cycle GHG emissions	communication about climate targets and achievements communication about company's good environmental practices	setting high energy efficiency targets ensuring energy efficiency targets trough the project; from planning to production promoting renewable energy (especially solar energy) sources
	Construction products and materials	**Construction site activities**	**LCA**	**Communication**	**Energy efficiency**

It is supposed, that level 1 which aim is to the compliance with current regulations has been already reached. In the model, Reactive approach includes actions which construction company should carry out based on results of customer interviews; actions which are needed to respond those stakeholders' insights. Proactive approach includes more advanced actions which are about to reduce climate impacts and surpass customers' expectations

7.3 Suggestions for further study

This thesis considered customer insights on creating a climate strategy for a construction company. However, it has been stated that the company is supposed to set measurable carbon targets for scope 1-3 emissions. Carbon neutrality is used in various organizations to describe targets to, for example, reach net zero GHG emissions during a one year, and reduce significantly GHG emissions in business areas or targets to reach independence from fossil fuels (Seppälä 2014). According to the literature and this study, especially cities has set carbon neutrality targets for GHG emissions. When the case company is considering emissions reduction targets it should be noticed that first step is to account caused GHG emissions. In this thesis, the main GHG emissions sources of a construction company were handled. As ENCORD guides, there are 12 emissions significant sources which should be considered and disclosing of GHG emissions should be done separately for operational units; residential building, commercial building as well as separately for infrastructure projects. In addition, other relevant sources of emissions should be included to GHG reporting. It would be recommended to carry out further study for defining carbon footprint of operational units of the company, which assesses CO2-eq emissions from the sources addressed by ENCORD and point out more detailed GHG reduction targets.

Contribution of construction processes in GHG reduction emissions were briefly discussed in this thesis. Especially understanding of environmental impacts of construction products as well as understanding life cycle GHG emissions were highlighted. It was briefly discussed that Building Informational Modelling (BIM) will be important tool of designer for assessing climate impacts of buildings in the design stage. Also, Green BIM for enhancing sustainability and collaboration trough the building's life cycle has been discussed in related literature (Wong & Zhou 2015 etc). Use of BIM in reducing climate impacts of buildings should be noticed in further reviews.

8 CONCLUSIONS AND SUMMARY

Climate change is a one of measurable seven planetary boundaries. Reducing climate impacts of the construction sector is crucial since the sector has an enormous contribution to climate change. The purpose of this thesis was to create actions for the construction company's climate strategy. Objectives the study were to find operations of a construction company which cause the most significant part of climate impacts of the construction company and identify stakeholders' targets related to managing of climate impacts. Suggested focus areas and actions for the strategy were found by carrying out data analysis from interviews research for stakeholders about their climate targets and insights.

In the beginning, a topic of the thesis referred to the company's carbon strategy. However, it was found that the climate strategy describes better the aim of the study, since carbon dioxide is a one of seven GHG emissions addressed, for example, by GHG Protocol's and ENCORD standard, which was focused in this study. Climate impact refers to caused GHG emissions or on the other word, carbon equivalent emissions. Thus, climate strategy brought a view that is more comprehensive for the study. In the beginning of the study, it was also purposing to focus on discussing about standards for the corporate and product level carbon footprint accounting. Later on, it was outlined to focus on especially the customer insights by empirical research and handle construction company's GHG emission sources by using scope 1, 2 and 3 as a framework for the results.

Scope 1 and 2 emissions are mandatory reported by a construction company for example by CDP. The most significant emissions sources from scope 1-2 are fuel and energy usage due to construction site activities. Indirect emissions from the companies' value chain covers often the biggest part of GHG emissions related to companies' activities. When it comes to construction companies, construction materials, especially production of steel and concrete causes the most enormous share of scope 3 emissions. Energy consumption in buildings can be included to indirect emissions of the construction company.

According to the results, real estate investors had their own sustainability and climate targets, which focused mainly on the operational energy consumption of buildings. It was found that

main factors which impact on choosing partners are responsibility of partner and illegal background as an excluding factor. Real estate investors assessed that there will be more pressure to decrease climate impacts during buildings' life cycle in the future. Pressure was seemed to be due to more stringent regulations, real estate investors as well as users of buildings. Investors' insights about the role of construction companies in responding their climate targets focused on scope 3 emissions of a construction company; increasing and ensuring energy efficiency and renewable energy solutions in the properties, as well as bringing out environmental data of material and construction products and promoting space flexibility in the properties. Environmental certificates were also addressed as targets which reduce environmental impacts of properties

Cities has developed their own climate change mitigation and adaptation strategies Cities and municipalities insights about construction companies was associated mainly to energy efficiency, construction materials, as well as efficient use of resources. It was found by the interviews of cities and municipalities that communications by construction companies about their abilities reduce environmental impacts would be needed. It was also found that cities and municipalities supposed that construction companies can bring out environmental insights and innovations to the projects as well as bring out ideas for cities climate and environmental agendas.

Five suggestions for focus areas for the climate strategy were identified as a result of this thesis. Three of the focus areas, 1. increasing knowledge of environmental data of construction products and materials, 2. monitoring and optimizing construction site activities as well as 3. ensuring energy efficiency of operational phase of buildings refer reducing GHG emissions from scopes 1-3. In addition, 4. promoting LCA practices and 5. Sustainability communication were found as relevant focus areas for the climate strategy.

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Questions for interviews

QUESTIONS FOR REAL ESTATE INVESTORS

- What kind of environmental responsibility targets does your organization have`?
- Do you assess the climate impacts caused by properties?
- Do environmental responsibility aspects impact on choosing partners or construction contractor?
- What kind of challenges have been observed when it comes to managing or decreasing climate impacts of building stock?
- What kind of solutions or data of you need from the construction sector in the near future? What are those methods how construction companies can support your climate targets?
- What are future views in the real estate sector when it comes to managing and reducing climate impacts?

QUESTIONS FOR CITIES AND MUNICIPALITIES

- Does the city have a climate strategy? What is a role of buildings in the climate target and/or strategy?
- Do you assess at the moment or will you assess climate impacts of new buildings in the near future?
- What kind of challenges have been observed when it comes to managing or decreasing climate impacts of a building stock?
- What kind of solutions or data does your organization need from the construction sector now or in the near future?
- What are those methods how construction companies can support your climate targets?
- What is your assumption about how new and existing buildings are included to climate strategies of cities in the future?

Example quotations of data analysis

Quotations	Simplified code	Category	Cluster/topic	Theme
We are very interested in wood construction possibilities	Interest in wood construction	Wood construction	materials	How construction companies can respond to climate targets of the organization
Just like data of construction materials and carbon footprints.	Data of environmental impacts of construction materials is desired	Data of environmental impacts of construction materials	materials	
Construction companies could help and bring out solutions and alternatives (material and construction products). It could be really and truly thought, which alternatives reduce the carbon footprint.	Data of environmental impacts of used construction materials is seemed as an important to be available	Data of environmental impacts of construction materials	materials	